US Army Corps
of Engineers
Wilmington District

Morehead City Harbor
Morehead City, NC

FINAL

Integrated Dredged Material Management Plan
And Environmental Impact Statement

Port of Morehead City, NC

June 2016

Morehead City Harbor
Morehead City, NC
FINAL
Integrated Dredged Material Management Plan (DMMP)
and Environmental Impact Statement

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Executive Summary

The U. S. Army Corps of Engineers (USACE), Wilmington District is responsible for the operation and maintenance of the federally-authorized Morehead City (MHC) Harbor navigation project. Engineer Regulation (ER) 1105-2-100 provides that a Dredged Material Management Plan (DMMP) be developed for federal navigation projects if a preliminary assessment does not indicate sufficient capacity to accommodate maintenance dredging for at least the next twenty years. The DMMP is a planning document to ensure that sufficient dredged material disposal facilities are available for at least the next 20 years and that maintenance dredging activities are performed in an environmentally acceptable manner, use sound engineering techniques, and are economically justified. The final product of this report will be an integrated DMMP and Environmental Impact Statement pursuant to the National Environmental Policy Act (NEPA). The DMMP addresses dredging needs, disposal capabilities, capacities of disposal areas, environmental compliance requirements, and potential for beneficial use of dredged material and indicators of continued economic justification. This DMMP will ensure sufficient disposal capacity for the 20-year period beginning in 2016 and extending through 2035.

The study area for the Morehead City Harbor DMMP includes the Morehead City Harbor navigation channels, the adjacent mainland area, the beaches of Bogue Banks and Shackleford Banks, the nearshore Atlantic Ocean off of Bogue Banks and Shackleford Banks which includes the current nearshore placement area, the U. S. Environmental Protection Agency (USEPA) designated Morehead City Ocean Dredged Material Disposal Site (ODMDS), and the existing disposal sites located on Brandt Island, Marsh Island, and Radio Island.

The integrated DMMP and Environmental Impact Statement (DMMP/EIS) evaluates the return of sand to the beaches of Shackleford Banks that was lost due to maintenance of the navigation channel. Shackleford Banks is part of the Cape Lookout National Seashore (CALO); the National Park Service (NPS) is a Federal cooperating agency on the Morehead City Harbor DMMP/EIS. Inclusion of a Shackleford Banks sand placement alternative in the DMMP was deemed prudent and consistent with scientific understanding of coastal processes and impacts.

The current Federal authorization for the Morehead City Harbor project consists of both deep draft and shallow draft channels. The deep draft portion of the project provides navigation channels from the deep water of the Atlantic Ocean to the North Carolina State Ports Authority (NCSPA) facilities at the Port of Morehead City. The shallow draft portion of the project provides for navigation channels from the waterfront docks at downtown Morehead City to the deep draft portion of the project. Dredging methods and disposal/placement options depend on the channel location and the *in situ* material characteristics. Based on these sediment characteristics and potential disposal locations, the deep draft channels or ranges[1] are grouped into three sections: the Inner Harbor, the Outer Harbor, and the Outer Entrance Channel.

Inner Harbor maintenance dredging historically has been accomplished by hydraulic pipeline dredge every 2 to 3 years, with disposal in either the disposal area at Brandt Island or on the beaches of Bogue Banks. The upland diked disposal facility at Brandt Island[2] has been used for project disposal since 1955. From 1978 through 2005, the majority of Inner Harbor dredged material was temporarily disposed of into the Brandt Island facility and later pumped onto the adjacent beaches of Fort Macon State Park and Atlantic Beach. These beach disposals (Brandt Island pumpouts) had the dual benefit of emptying the disposal area and providing material for the area of beach potentially affected by the dredging activities of the navigation project, more than offsetting shoreline impacts associated with changes in sediment transport attributable to the Federal navigation project (USACE 1976 General Design Memorandum, and USACE 2001 Section 111 Report). Both the General Design Memorandum and the Section 111 report prepared for this project specifically recognized that beach impacts from the navigation project were offset by the Brandt Island pumpouts.

The last Brandt Island pumpout (2005) was problematic in that it included placement of an unacceptable amount of fine-grained material onto the beach. This disposal of fine-grained material on the beach, along with recent USACE geotechnical investigations, indicates that Brandt Island and portions of the Inner Harbor contain material unfit for beach placement. Since 2005, only fine-grained dredged material has been disposed of in Brandt Island. Coarse-grained material has been placed on the beaches of Fort Macon State Park and Atlantic Beach, within the existing Nearshore Placement Area west of Beaufort Inlet, in the ODMDS, or on the shoreline of Pine Knoll Shores as part of a beneficial use of dredged material project (pursuant to Section 933 of the Water Resources Development Act of 1986 (Public Law 99-662)). Due to the presence of fine-grained material in Brandt Island and the cost that would be incurred to attempt to separate the fine-grained material from the remaining coarse-grained material, it is no longer economically feasible to do the Brandt Island pumpouts; therefore, there are no plans for future pumpouts from Brandt Island to the beaches.

The Outer Harbor and Outer Entrance Channel maintenance dredging have historically been accomplished by hopper or pipeline dredge on an annual basis. Dredged material from the Outer Harbor has historically been disposed of in Brandt Island along with Inner Harbor material or has been deposited by hopper dredge in the ODMDS, but more recently has been placed in the approved Nearshore Placement Area west side of Beaufort Inlet or on area beaches. The Outer Entrance Channel material, which is fine-grained material, is typically disposed of in the ODMDS within the southwest corner,

[1] Ranges are segments of channels.
[2] Although not all of Brandt Island is occupied by the upland diked diposal facility, in this document reference to “Brandt Island” refers specifically to the disposal facility unless clearly indicated otherwise.

which is the area designated for fine-grained material (less than 90 percent sand). The northern half of the Morehead City ODMDS is designated for dredged material that is coarse-grained (greater than 90 percent sand), making it an accessible source of sand for future beach replenishments.

The Morehead City shallow-draft portion of the Harbor project has not been dredged in over 15 years. Although these ranges were considered during the development of the DMMP, they are dredged so infrequently and contain such small quantities of material (~50,000 cubic yards of fine-grained material and ~50,000 cubic yards of coarse-grained sand) that they would not affect the base plan and therefore were not included in the detailed analyses conducted for all other portions of the Harbor.

Sediment sampling efforts conducted between 2003 and 2008 identified that large portions of the Inner Harbor material consists of fine-grained material that is less than 90 percent sand. As a general rule, placement of dredged material on beaches is limited to that material which is greater than or equal to 90 percent sand. Therefore, Inner Harbor material is not suitable for placement onto adjacent shorelines. Sampling also showed that the majority of the shoaled material located in the Outer Harbor consists of coarse-grained material that is suitable for beach or nearshore placement, with the exception of material in the Outer Entrance Channel from Station 110+00 seaward. This new sediment data, combined with the inability to offset potential project impacts through Brandt Island pumpouts, led to the District's creation of a revised management strategy for the Morehead City Harbor project, termed the Interim Operations Plan (IOP). The Environmental Assessment and Finding of No Significant Impact (EA/FONSI) for the IOP were completed in July 2009 and addressed modifications to the existing Morehead City Harbor dredged material disposal practices for an interim period while the Morehead City Harbor DMMP is being developed. The IOP, which is the current base plan, provides for Morehead City Harbor maintenance dredging utilizing a repeating three-year dredging cycle. The IOP was developed using past dredging quantities, recent geotechnical data, and current channel and disposal area conditions.

The first step of the DMMP process was the preparation of the Preliminary Assessment (PA), which was completed by the USACE, Wilmington District in 1997 (USACE, 1997). The PA concluded that there were no significant problems to the continued maintenance of the Morehead City Harbor project; therefore, a DMMP was not recommended. Since 1997, changes have occurred regarding the management of dredged material from Morehead City Harbor. In the past, capacity in the Brandt Island confined disposal site was periodically restored when the material from Brandt Island was pumped to the beach. Because pumpouts are no longer a feasible option, since 2005 (the last pumpout), only fine-grained material has been disposed of in Brandt Island. To address these changes and the implications for future management of the Harbor, development of a formal dredged material management plan is now warranted.

The initial phase of the DMMP began with the identification of dredged material management problems and opportunities, the procedure used to identify measures, and the methodology used to select alternatives for further analysis. Resource agency and public involvement began in 2009 when a public meeting was held to brief attendees on the Morehead City Harbor DMMP project and process, to solicit comments and input, and to invite attendees to participate on the Project Delivery Team (PDT). Attendees included representatives from state and federal resource agencies, interest groups, and stakeholders. Several attendees expressed an interest in participating on the PDT and have actively participated in the development of the DMMP.

This DMMP for the Morehead City Harbor project has been developed using a consistent and logical procedure by which dredged material management measures have been identified, evaluated, screened, and recommended so that dredged material disposal operations are conducted in a timely, environmentally sensitive, and cost-effective manner. Following identification of problems and opportunities, the PDT identified 21 potential DMMP measures for the Morehead City Harbor DMMP which resulted in more than 100 dredging and disposal options to be analyzed for the base plan. Analysis and screening of the measures during the plan formulation process resulted in the elimination of several of the DMMP measures. As shown in the table below, those measures that remain viable were combined to form the recommended base plan.

DMMP Cycle	Harbor Section	Navigation Range Dredged	Dredge Plant	Proposed Disposal/Placement Location	Quantity Likely to be Dredged (cy)	Estimated Cost (per dredging event)*
Years 1,4,7,10 …	Outer	South Range B Cutoff North Range A to Station 110+00	30-inch** pipeline	Fort Macon State Park & Atlantic Beach***	1,200,000	~$18,839,800
Years 2,5,8,11 …	Outer	South Range C to North Range B	Hopper or pipeline	Nearshore West &/or East	346,000	~$7,571,000
	Outer	South Range B Cutoff North Range A to Station 110+00	Hopper or pipeline	Nearshore West &/or East	650,000	
Years 3,6,9,12 …	Inner	Northwest Leg West Legs 1 & 2 East Leg & North Range C	18-inch pipeline	Brandt Island or ODMDS	514,000	~$12,219,900****
	Outer	South Range B Cutoff North Range A to Sta. 110+00	Hopper or pipeline	Nearshore West &/or East	810,000	
	Outer Entrance	South Range A from Station 110+00 out	hopper	ODMDS	344,000	

* Costs include monitoring, mobilization/demobilization, planning, engineering and design, supervisory and administrative costs and 27% contingency
** Costs estimates are based on the specific pipeline sizes this table; however comparable sized pipeline dredges could be used
***Non-federal entities may contribute funds through an Additional Work Memorandum of Agreement (MOA) for dredging with placement of beach quality material on Bogue Banks beaches. Refer to section 3.2 for details.
**** When Inner Harbor material is disposed of in the Ocean Dredged Material Disposal Site (ODMDS) (once Brandt Island reaches capacity), costs increase to $14,101,200 per dredging event.

Inner Harbor fine-grained material would be disposed of in Brandt Island until it reaches capacity in 2028, at which time this material would be disposed of in the ODMDS. An essential component of the proposed base plan is beneficial use of dredged material by placement on the adjacent beaches and in nearshore placement areas within the ebb tide delta at regular intervals to ameliorate the possible losses of material caused by dredging. The 2001 Section 111 Report, which examined the erosive effects of the project, concluded that beach placement on the Fort Macon State Park and Atlantic Beach shorelines was "an integral part of the operation and maintenance of the project," and that the placement of approximately 5 million cubic yards (cy) of material between 1978 and 2001 "provided more than adequate compensation or mitigation for this possible impact." In the past, the NPS did not want any sand from the channel placed on Shackleford Banks. As a result of new information regarding navigation channel impacts on Shackleford Banks, in 2010, the NPS requested that sand placement on Shackleford Banks be considered in the DMMP. Therefore, the draft DMMP evaluated placement of beach quality dredged material on Fort Macon State Park, Atlantic Beach and Shackleford Banks. Following circulation of the Draft DMMP, the NPS requested dismissal of the alternative to place dredged material on Shackleford Banks, as the NPS did not have adequate information to conclude that sand placement in the quantities and locations described in the DMMP was the preferred solution to ameliorate potential dredging-related effects. So, although the USACE continues to recommend that coarse-grained dredged material (sand) be placed on Shackleford Banks, it is the determination of NPS that no sand will be placed on Shackleford Banks as part of this DMMP. Another very important component of the DMMP is the placement of dredged material in the nearshore placement areas with the expected benefit of reducing erosion of the ebb tide delta, also referred to as ebb tide delta deflation. For this reason, in years 2 and 3 of the 3-year maintenance cycle, the base plan recommends placement of coarse-grained material (greater than or equal to 90% sand) in nearshore placement areas on both sides of Beaufort Inlet.

The placement of dredged material in the nearshore placement areas is expected to contribute to the stability of the ebb tide delta, which is part of the littoral system, thus positively affecting the littoral system and the associated features. Disposal of material directly on Fort Macon and Atlantic Beach would continue to reduce erosion along the beaches of Bogue Banks. However, any time dredged material is not placed in the ebb tide delta, it may adversely affect the deflating ebb tide delta. An understanding of coastal inlet processes suggests that continued erosion of the ebb tide delta is likely to eventually impact the adjacent beaches. The locations, severity, and timing of the impact are unknown at this time. It is likely that any impact to the shoreline along Bogue Banks up to this point has been offset by previous disposal of federal navigation maintenance material along the eastern end of the island as found by the Section 111 report. Continued deflation of the ebb tide delta, however, may eventually overtake those efforts. Every practical and sound effort, including reasonable use of light-loaded vessels, use of dump scows, and direct pipeline to the nearshore, will be made to retain littoral material dredged from the navigation channels within the inlet complex to minimize this ebb tide delta deflation. A physical monitoring program, as outlined in the Morehead City Harbor Monitoring Plan, will provide data to potentially modify and assess ongoing operations and their impacts.

The proposed Morehead City Harbor DMMP is not expected to result in any significant adverse environmental effects. Significant resources (including terrestrial and marine biota, cultural resources, threatened and endangered species, air and water quality, socio-economics, aesthetics, and recreation) will not be adversely impacted by implementation of the proposed DMMP. Localized, short-term, and reversible adverse impacts to intertidal macrofauna (beach infauna) may occur. However, beach placement areas on Bogue Banks would recover quickly since only beach-compatible material (greater than or equal to 90% sand) would be placed on these beaches. Supportive data for these conclusions are found in Section 5.5 entitled Marine and Estuarine Resources and in Appendix J, USFWS and NOAA Biological Assessment.

The three-year dredging cycle proposed for the DMMP assumes that funding will be available to dredge and monitor as planned, appropriate dredge equipment will be available, and that unexpected shoaling would not occur. The three-year rotational cycle is the base plan, but must remain flexible and adjustable to meet the navigation needs of the Morehead City Harbor navigation project; therefore, from time to time, the cycle may be adjusted, resulting in fewer dredging events, differences in the disposal/placement location cycle, and dredged material quantities that differ from those described in this DMMP. Nothing in this document should be read to suggest that material will be dredged for the purpose of placement on the beaches or in the nearshore, or for any purpose other than addressing navigability priorities.

In summary, approximately 1 million cubic yards of dredged material are removed from the Morehead City Harbor annually. Current maintenance disposal practices, without modification, result in the need for "new" or expanded disposal sites or modified disposal options, including beneficial uses, by 2028. The proposed DMMP (base plan) provides virtually unlimited disposal capacity for the Morehead City Harbor navigation project by recommending the following: continued use of Brandt Island without expansion, disposal of coarse-grained material on the beaches of Fort Macon State Park and Atlantic Beach, expansion of the Nearshore West placement area, a new Nearshore East Placement Area, and continued use of the USEPA designated ODMDS. Although Brandt Island will reach capacity before the end of the 20-year period covered by the DMMP, dredged material that goes to Brandt Island may be disposed of in the ODMDS, so sufficient capacity for the harbor is not limited by Brandt Island. It should be noted that placement of beach quality material on Shackleford Banks is still recommended by the USACE; however, at the request of the NPS, no beach-quality dredged material will be placed on Shackleford Banks as part of this DMMP.

Implementation of the DMMP is estimated to cost approximately $13,662,000 annually. The maintenance dredging of the project is 100% federally funded. The only costs incurred by the State of North Carolina, the non-federal partner, are approximately $50,000 annually for maintenance of the spillway boxes at Brandt Island. In conclusion, Brandt Island, the beaches of Fort Macon State Park and Atlantic Beach, the existing and proposed nearshore placement areas and the EPA designated ODMDS provide adequate disposal capacity for maintenance of the Morehead City Harbor navigation project to its fully authorized dimensions for at least the next 20 years. The proposed base plan will provide more than adequate disposal capacity to maintain the Morehead City Harbor navigation project to the fully authorized dimensions for at least the next 20 years. A concise summary of this DMMP is captured in the Morehead City Harbor Operations Plan, which immediately follows the DMMP Executive Summary.

ACRONYMS

AAC	average annual cost
AFB	Alternative Formulation Briefing
AFT	Aviation Fuel Terminals, Inc.
AIWW	Atlantic Intracoastal Waterway
AP	Albemarle-Pamlico
AR	artificial reef
ASA(CW)	Assistant Secretary of the Army for Civil Works
AST	above-ground storage tank
ASTM	American Society for Testing and Materials
ATR	Agency Technical Review
BA	Biological Assessment
BBSPP	Bogue Banks Shore Protection Project
BC	berm crest
BMAP	Beach Morphology Analysis Program
BO	Biological Opinion
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
CAA	Clean Air Act
CALO	Cape Lookout National Seashore
CAMA	Coastal Area Management Act
CBRA	Coastal Barrier Resources Act
CBRS	Coastal Barrier Resources System
CEDEP	Corps of Engineers Dredging Estimating Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
CHIRP	Compressed High Intensity Radar Pulse
COLREGS	International Regulations for Preventing Collisions at Sea
CPT	Channel Portfolio Tool
CPU	cone penetrometer units
CWB	colonial waterbird
cy	cubic yards
CZMA	Coastal Zone Management Act
DAP	diammonium phosphate
DB	dune base
DE	Delaware
DEIS	Draft Environmental Impact Statement
DMMP	Dredged Material Management Plan

DN	Dune
DOQQ	Digital Orthophoto Quarter Quads
DWT	dead weight tons
EA	Environmental Assessment
EA/FONSI	Environmental Assessment and Finding of No Significant Impact
EC	Engineer Circular
EDR	E Data Resources, Inc.
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
elev	Elevation
EP	Engineer Pamphlet
EPM	Equilibrium Profile Method
ER	Engineer Regulation
ERDC	Engineering Research and Development Center
FEMA	Federal Emergency Management Agency
FONSI	Finding of No Significant Impact
FSC	Federal species of concern
FT	Feet
GI	General Investigation
GIS	Geographic Information System
G.S.	General Statute
HAPC	Habitat Areas of Particular Concern
H.D.	House Document
HMTF	Harbor Maintenance Trust Fund
HQW	High Quality Water
HTRW	hazardous, toxic and radioactive wastes
IEPR	Independent External Peer Review
IH	Inner Harbor
IOP	Interim Operations Plan
ITM	Inland Testing Manual
LLC	Limited Liability Corporation
LST	landing ship, tank
MANLAA	may affect not likely to adversely affect
MALAA	may affect likely to adversely affect
MAP	monoammonium phosphate
MCACES	Microcomputer Aided Cost Engineering System
MDS	maximum density separators
MHC	Morehead City Harbor
mhw	mean high water

mlw	mean low water
mllw	mean lower low water
MMS	Minerals Management Service
MOA	Memorandum of Agreement
MPRSA	Marine Protection, Research, and Sanctuaries Act
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MSL	mean sea level
NAVD88	North American Vertical Datum of 1988
NC	North Carolina
NCAC	North Carolina Administrative Code
NCARP	North Carolina Artificial Reef Project
NCCMP	North Carolina Coastal Management Program
NCDCM	North Carolina Division of Coastal Management
NCDENR	North Carolina Department of Environment and Natural Resources
NCDEQ	North Carolina Department of Environmental Quality
NCDMF	North Carolina Division of Marine Fisheries
NCDWQ	North Carolina Division of Water Quality
NCDWR	North Carolina Division of Water Resources
NCSPA	North Carolina State Ports Authority
NEC	not elsewhere classified
NED	National Economic Development
NEPA	National Environmental Policy Act
NLAM	not likely to adversely modify
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
NOI	Notice of Intent
NPS	National Park Service
NRC	National Research Council
NSP	nearshore placement
NTU	nephelometric turbidity unit
O & M	Operations and Maintenance
OCS	Outer Continental Shelf
ODMDS	Ocean Dredged Material Disposal Site
OEC	Outer Entrance Channel
OH	Outer Harbor
OMB	Office of Management and Budget
ORV	off road vehicles
ORW	Outstanding Resource Water
OW	Overwash

PA	Preliminary Assessment
PL	Public Law
PDT	Project Delivery Team
PGL	Policy Guidance Letter
PNA	Primary Nursery Area
ppt	parts per thousand
QAR	Queen Anne's Revenge
RFQ	Request for Qualifications
RSM	Regional Sediment Management
SAD	South Atlantic Division
SAFMC	South Atlantic Fishery Management Council
SARBA	South Atlantic Regional Biological Assessment
SAV	submerged aquatic vegetation
SEAMAP	Southeast Monitoring and Assessment Program
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SUP	Special Use Permit
T & E	Threatened and Endangered [Species]
TR	Trough
UAB	Underwater Archaeology Branch
USACE	U. S. Army Corps of Engineers
USC	U. S. Code
USCG	U.S. Coast Guard
USFWS	U. S. Fish and Wildlife Service
UST	underground storage tank
USVI	U. S. Virgin Islands
UTM	Universal Transverse Mercator
VIMS	Virginia Institute of Marine Science
WCSC	Waterborne Commerce Statistics Center
WRDA	Water Resources Development Act
μPa	micropascal

US Army Corps
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Morehead City Harbor
Morehead City, NC

OPERATIONS PLAN

Port of Morehead City, NC

June 2016

Morehead City Harbor
Morehead City, NC
OPERATIONS PLAN
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1.0 Executive Summary

The U. S. Army Corps of Engineers (USACE), Wilmington District is responsible for the operation and maintenance of the federally-authorized Morehead City (MHC) Harbor navigation project. In accordance with Engineer Regulation (ER) 1105-2-100, a Dredged Material Management Plan (DMMP) for Morehead City Harbor has been developed. The Final DMMP ensures that sufficient dredged material disposal facilities are available for at least the next 20 years (Fiscals Years 2017-2036) and that maintenance dredging activities are performed in an environmentally acceptable manner, use sound engineering techniques, and are economically justified. The DMMP addresses, in detail, dredging needs, disposal capabilities, capacities of disposal areas, environmental compliance requirements, beneficial use of dredged material and indicators of continued economic justification.

This Operations Plan (Ops Plan) consists of a brief summary of the DMMP and should be used to guide future maintenance dredging and disposal practices for the Morehead City Harbor federal navigation project. Maintenance of the Morehead City Harbor navigation project is based on a 3-year dredging and disposal cycle. This Ops plan provides virtually unlimited disposal capacity for the Morehead City Harbor navigation project by recommending the following: continued use of Brandt Island without expansion, disposal of beach-quality material on the beaches of Fort Macon State Park and Atlantic Beach, expansion of the existing Nearshore West Placement Area, a new Nearshore East Placement Area, and continued use of the U. S. Environmental Protection Agency's (EPA) designated Ocean Dredged Material Disposal Site (ODMDS). It should be noted that placement of beach quality material on Shackleford Banks is still recommended by the USACE; however, at the request of the National Park Service (NPS), no beach-quality dredged material will be placed on Shackleford Banks.

The DMMP assumes that the Morehead City Harbor navigation project will be maintained to the fully authorized project dimensions; therefore it is assumed that funding will be available to dredge and monitor as planned, appropriate dredge equipment will be available, and unexpected shoaling will not occur. In reality, maintaining the MHC Harbor project to the fully authorized project dimensions is estimated to cost approximately $13.6 million per year; however, actual funding received for MHC since 2009 has averaged only $10.7 million per year, frequently resulting in dredged volumes that are less than those required to maintain the channel to full dimensions. Therefore, as demonstrated in Table 1 (Section 2) the three-year rotational cycle must remain flexible and adjustable to meet the navigation needs of the Morehead City Harbor navigation project and may, from time to time, be adjusted, resulting in fewer dredging events, different dredge plant, a different use of disposal locations, and/or dredged material quantities that differ from those described in this Plan.

Every reasonable effort will be made to accomplish maintenance of the Morehead City Harbor project within established environmental windows. Should circumstances require that work be accomplished outside of the windows, the USACE will communicate/coordinate the action with all appropriate resource agencies prior to start of work.

2.0 Morehead City Harbor Project Description

Morehead City Harbor is located in the Town of Morehead City, North Carolina, approximately 3 miles from the Atlantic Ocean through Beaufort Inlet. The current federal authorization for the Morehead City (MHC) Harbor project consists of both deep draft and shallow draft channels. The deep draft portion of the project provides navigation channels from the deep water of the Atlantic Ocean to the North Carolina State Ports Authority (NCSPA) facilities at the Port of Morehead City. The shallow draft portion of the project provides for navigation channels from the waterfront docks at downtown Morehead City to the deep draft portion of the project. All channels within the MHC Harbor project, including channel dimensions, are shown on Figure 1.

In addition to the federally-maintained navigation channels, the State of North Carolina, as the non-federal project sponsor, is responsible for maintenance dredging within those berthing areas that are not included within the federal authorization. The non-federal berthing areas include Berths 1-3, 4-7, the Barge Dock, and the Aviation Fuel Terminal, and are shown on Figure 1. Berths 8 and 9 are part of the federally-authorized project and therefore are federally maintained. The principal user of these berths is the U. S. Military.

<u>Morehead City Harbor – deep draft portion (Outer Harbor & Outer Entrance Channel</u>

Range A:	47-ft deep mean lower low water (mllw) by 450 to 650 feet wide from deep water in the Atlantic Ocean to Beaufort Inlet; step cut as shown in Figure 1
Cutoff:	45 feet deep mllw with varying width; connecting Range A with Range B.
Range B:	45 feet deep mllw by 400 feet wide; connecting the Cutoff channel with Range C.

<u>Morehead City Harbor – deep draft portion – Inner Harbor</u>

Range C:	45 feet deep mllw by varying width of approximately 400 to 1,350 feet; connecting Range B with East and West Legs. (includes a turning basin in Range C and a portion in the West Leg that is 1,350 feet in diameter);
East Leg:	45 feet deep mllw by a varying width of approximately 800 to 1,000 feet; connecting Range C with the non-federal berthing areas located east of the NCSPA facility.
West Leg:	35 feet deep mllw by approximately 780 feet wide; connecting Range C with the non-federal berthing areas located south of the NCSPA facility and with the Northwest Leg.

Northwest Leg:	35 feet deep mllw by approximately 1,200 feet wide; Note: federal authorization of the Northwest Leg extends to the West facing bulkhead of the NCSPA facility (i.e., there is no non-federal berthing area located west of the NCSPA facility).

<u>Morehead City Harbor – shallow draft portion (in front of Morehead City)</u>

Range 2:	12 feet deep mllw by 100 feet wide from the Northwest Leg to Sixth Street along the Morehead City Waterfront
Basin :	12 feet deep mllw by 200 to 400 feet wide from Sixth Street to Tenth Street along the Morehead City Waterfront
Range 4:	6 feet deep mllw by 75 feet wide from Tenth Street to the Atlantic Intracoastal Waterway in Bogue Sound

In 2009, the Interim Operations Plan (IOP) was implemented to address modifications to the Morehead City Harbor dredged material disposal practices for an interim period while the Morehead City Harbor DMMP was being developed. The IOP is based on a 3-year maintenance cycle that includes:

	Dredging Area	Disposal/Placement Location	Approx. Quantity
Year-1	Outer Harbor (90% sand)	Fort Macon State Park Atlantic Beach	1,100,000 cubic yards
Year-2	Ocean Bar (90% sand)	Nearshore Placement Area	250,000 cubic yards
	Inner Harbor	Brandt Island	700,000 cubic yards
Year-3	Outer Harbor (90% sand)	Nearshore Placement Area	750,000 cubic yards
	Inner Harbor	ODMDS	100,000 cubic yards

Table 1, below, includes a summary of MHC Harbor maintenance dredging activities since the IOP was implemented. During this time, approximately $10.7 million has been received annually for maintenance of the MHC Harbor project. As demonstrated in Table 1, funding limitations frequently require alterations to the IOP 3-year cycle, which results in fewer dredging events, use of different dredge plant and/or different disposal locations, and dredged material quantities that are less than quantities required to fully maintain the project to its authorized dimensions. The shallow-draft portion of the Morehead City Harbor has not been dredged in over 15 years and does not require regular maintenance; therefore, the table below does not include these ranges.

Year	IOP Year	IOP Plan followed	Scheduled Maintenance	Actual Maintenance	Scheduled disposal location	Actual disposal location	Cubic yards dredged	Awardable Bids?	Notes
2009	1	Year 1	Range A Cutoff	Inner Harbor	Beaches of Ft. Macon and Atlantic Beach	ODMDS	600,000	Yes	No awardable bids received for Ocean Bar Contract; McFarland (gov't dredge) did minimal necessary dredging.
2010	2	Year 1	Range A Range B Cutoff	Range A Range B Cutoff	Beaches of Ft. Macon and Atlantic Beach	Beaches of Ft. Macon and Atlantic Beach	1,400,000	Yes	SAW elected to re-attempt Year 1 maintenance due to lack of awardable bids in previous year
2011	3	Year 3	Inner Harbor	Inner Harbor	ODMDS	ODMDS	470,000	Yes	SAW followed the Year 3 plan due to the need to maintain the Inner Harbor
2012	1	Year 2	Range A Cutoff	Range A Cutoff	Nearshore	Nearshore	400,000	No	No awardable bids received;McFarland did minimal necessary dredging
2013	2	Year 2	Range A Range B Cutoff	Range A Cutoff	Nearshore	Nearshore	420,000	No	SAW elected to re-attempt Year 2 maintenance due to small quantity dredged the year before, and due to limited funding. No awardable bids received;McFarland did minimal necessary dredging
2013 (2nd job)	2	Year 2	Range A Range B Cutoff	Cutoff	Nearshore	Nearshore	575,000	Yes	Pipeline dredge mobilized to deal with critical shoaling off the tip of Shackleford Island. Scows were used for nearshore placement.
2014	3	Year 1	Inner Harbor	Range A Cutoff	Beaches of Ft. Macon and Atlantic Beach	Beaches of Ft. Macon and Atlantic Beach	790,000	Yes	Successful Year 1 maintenance event
2015	1	Year 2	Range A Cutoff	None	Nearshore	-	-	No	No awardable bids received
2015 (2nd job)	1	Year 2	Range A Cutoff	Range A Cutoff	Nearshore	Nearshore / Ft. Macon	855,000	Yes	Pipeline dredge mobilized to deal with critical shoaling off the tip of Shackleford Island. Scows were used for nearshore placement.
2016	2	Year 3	Range A	None	Nearshore	None	-	No	No awardable bids received for Nearshore Placement Area disposal
2016 (2nd job)	2	Year 3	Range A	Range A	Nearshore	ODMDS	665,000	Yes	ODMDS disposal authorized after lack of awardable bids to Nearshore.

Table 1. Morehead City Harbor Maintenance Dredging and Disposal (2009-present)

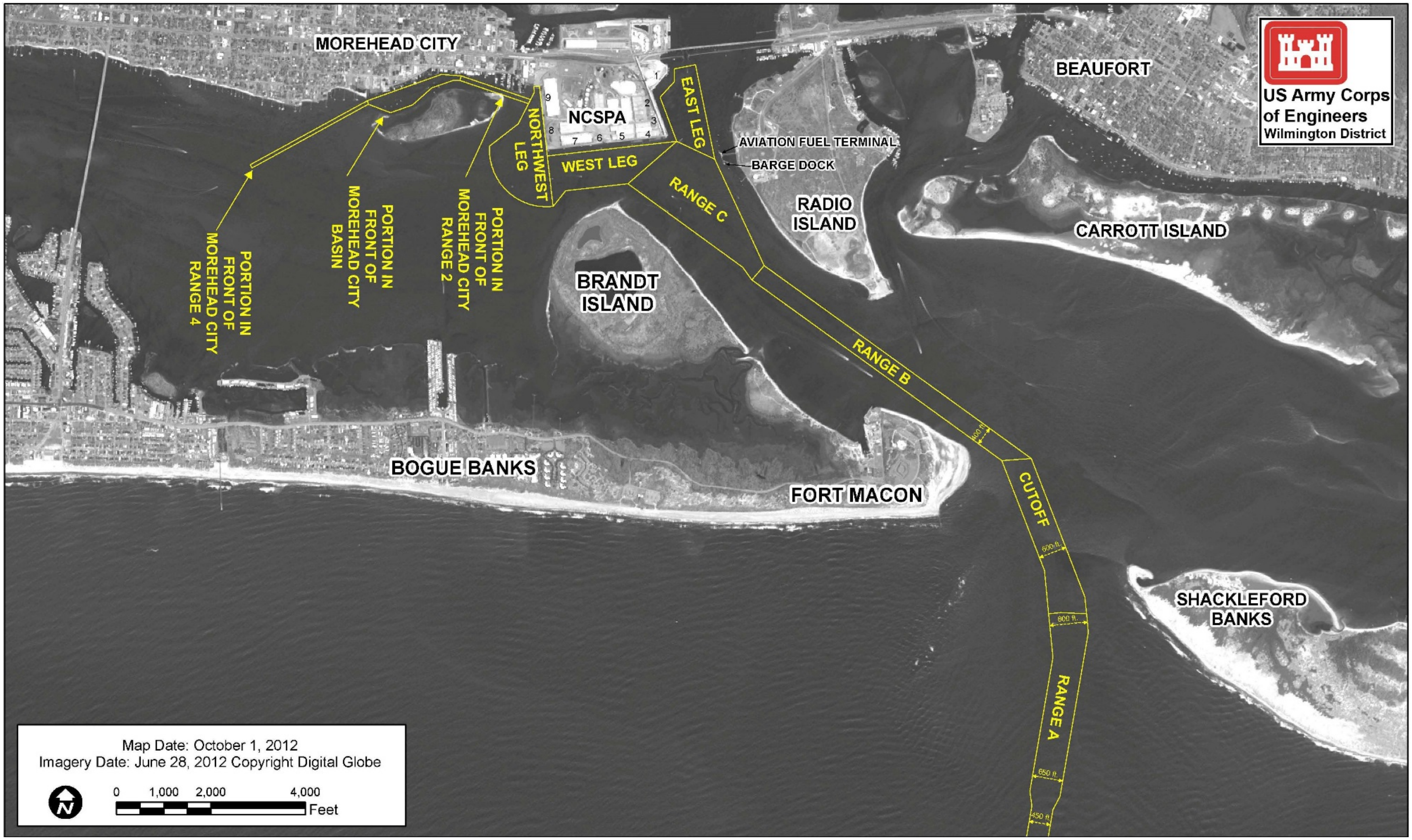


Figure 1. Morehead City Harbor Federally Authorized Navigation Project

3.0 Operations Plan

Maintenance of the MHC Harbor project is based on a 3-year cycle that most effectively matches anticipated dredge plant with the areas that need to be maintained. This plan is the best balance of dredging needs, available dredge plant, environmental concerns, and costs. Although dredged material from most of the MHC project ranges may be disposed of in more than one location, Tables 2 and 3 display the plan that meets the Federal standard of least cost, engineeringly sound and environmentally acceptable disposal. Actual ranges dredged, and the dredge plant utilized, may vary from the plan due to yearly navigational priorities and the actual bids received. The 3-year cycle is graphically depicted in Figures 2 through 4. Figure 5 shows a summary of all dredging and disposal locations. Quantities shown in the tables are based on adjusted shoaling rates (refer to Section 5 for shoaling rate explanation) and represent the material likely to be dredged in order to maintain the channel to authorized dimensions. However, due to funding limitations and navigation priorities, actual dredging quantities from the Morehead City Harbor channels will vary and are expected to be less than the quantities shown.

DMMP Cycle	Harbor Section	Navigation Range Dredged	Dredge Plant	Proposed Disposal/Placement Location	Quantity Likely to be Dredged (cy)	Estimated Cost (per dredging event)*
Years 1, 4, 7, 10…	Outer	South Range B Cutoff North Range A to Station 110+00	30-inch** pipeline	Fort Macon State Park & Atlantic Beach***	1,200,000	~$18,839,800
Years 2, 5,8,11…	Outer	South Range C to North Range B	Hopper or pipeline	Nearshore West & East	346,000	~$7,571,000
	Outer	South Range B Cutoff North Range A to Station 110+00	Hopper or pipeline	Nearshore West & East	650,000	
Years 3,6,9,12…	Inner	Northwest Leg West Legs 1 & 2 East Leg & North Range C	18-inch pipeline	Brandt Island or ODMDS	514,000	~$12,219,900****
	Outer	South Range B Cutoff North Range A to Sta. 110+00	Hopper or pipeline	Nearshore West & East	810,000	
	Outer Entrance	South Range A from Station 110+00 out	hopper	ODMDS	344,000	

* Costs include monitoring, mobilization/demobilization, planning, engineering and design, supervisory and administrative costs and 27% contingency

** Cost estimates are based on the specific pipeline sizes in this table; however comparable sized pipeline dredges could be used

***Non-federal entities may contribute funds through an Additional Work Memorandum of Agreement (MOA) for dredging with placement of beach quality material on Bogue Banks beaches. Refer to section 6.2 of this Plan for details.

**** When Inner Harbor material is disposed of in the Ocean Dredged Material Disposal Site (ODMDS) (once Brandt Island reaches capacity), costs increase to $14,101,200 per dredging event.

Table 2. Operations Plan (FY2017-2036)

				Estimated Dredged Material Quantity (cu. yds.)			
DMMP Year	**Fiscal Year**	**Harbor Section**	**Sediment Quality**	**Nearshore**	**Beach**	**Brandt Island**	**ODMDS**
1	2017*	Outer	coarse-grained**		1,200,000		
2	2018	Outer	coarse-grained	996,000			
3	2019	Inner	fine-grained***			514,000	
		Outer	coarse-grained	810,000			
		Outer Entrance Channel	fine-grained				344,000
4	2020	Outer	coarse-grained		1,200,000		
5	2021	Outer	coarse-grained	996,000			
6	2022	Inner	fine-grained			514,000	
		Outer	coarse-grained	810,000			
		Outer Entrance Channel	fine-grained				344,000
7	2023	Outer	coarse-grained		1,200,000		
8	2024	Outer	coarse-grained	996,000			
9	2025	Inner	fine-grained			514,000	
		Outer	coarse-grained	810,000			
		Outer Entrance Channel	fine-grained				344,000
10	2026	Outer	coarse-grained		1,200,000		
11	2027	Outer	coarse-grained	996,000			
12	2028	Inner	fine-grained			514,000	
		Outer	coarse-grained	810,000			
		Outer Entrance Channel	fine-grained				344,000
13	2029	Outer	coarse-grained		1,200,000		
14	2030	Outer	coarse-grained	996,000			
15	2031	Inner	fine-grained			514,000	
		Outer	coarse-grained	810,000			
		Outer Entrance Channel	fine-grained				344,000
16	2032	Outer	coarse-grained		1,200,000		
17	2033	Outer	coarse-grained	996,000			
18	2034	Inner	fine-grained			514,000	
		Outer	coarse-grained	810,000			
		Outer Entrance Channel	fine-grained				344,000
19	2035	Outer	coarse-grained		1,200,000		
20	2036	Outer	coarse-grained	996,000			
		Inner	fine-grained			514,000	
		Outer Entrance Channel	fine-grained				344,000
			TOTALS	**11,832,000**	**8,400,000**	**3,598,000**	**2,408,000**

* The DMMP will be completed in October 2016 (Fiscal Year 2017)

**coarse-grained = dredged material ≥90% sand ***fine-grained = dredged material <90% sand

Table 3. Proposed DMMP Cycle - Sediment Quality & Disposal/Placement Locations

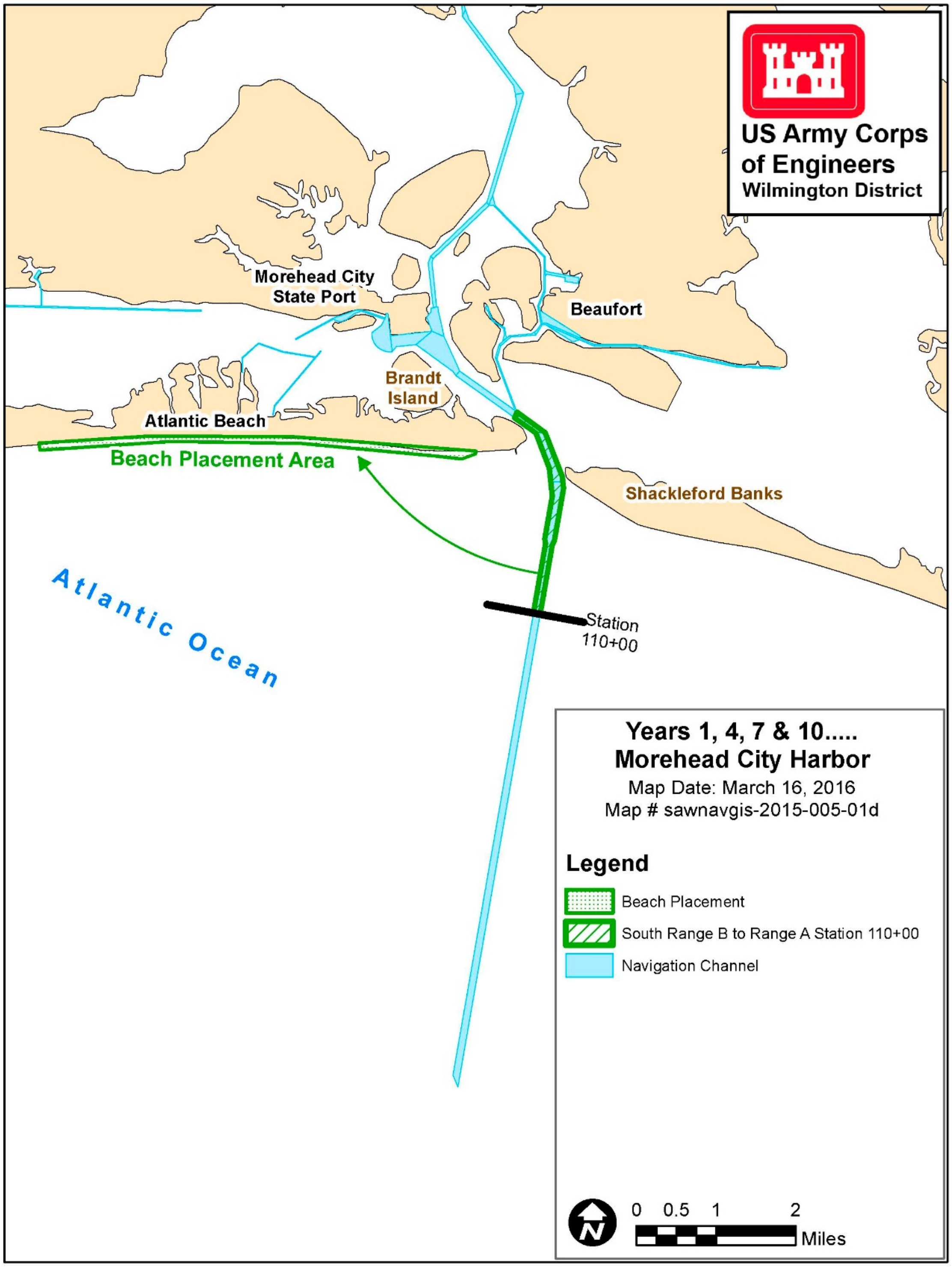


Figure 2. Operations Plan – Years 1,4,7,10…….

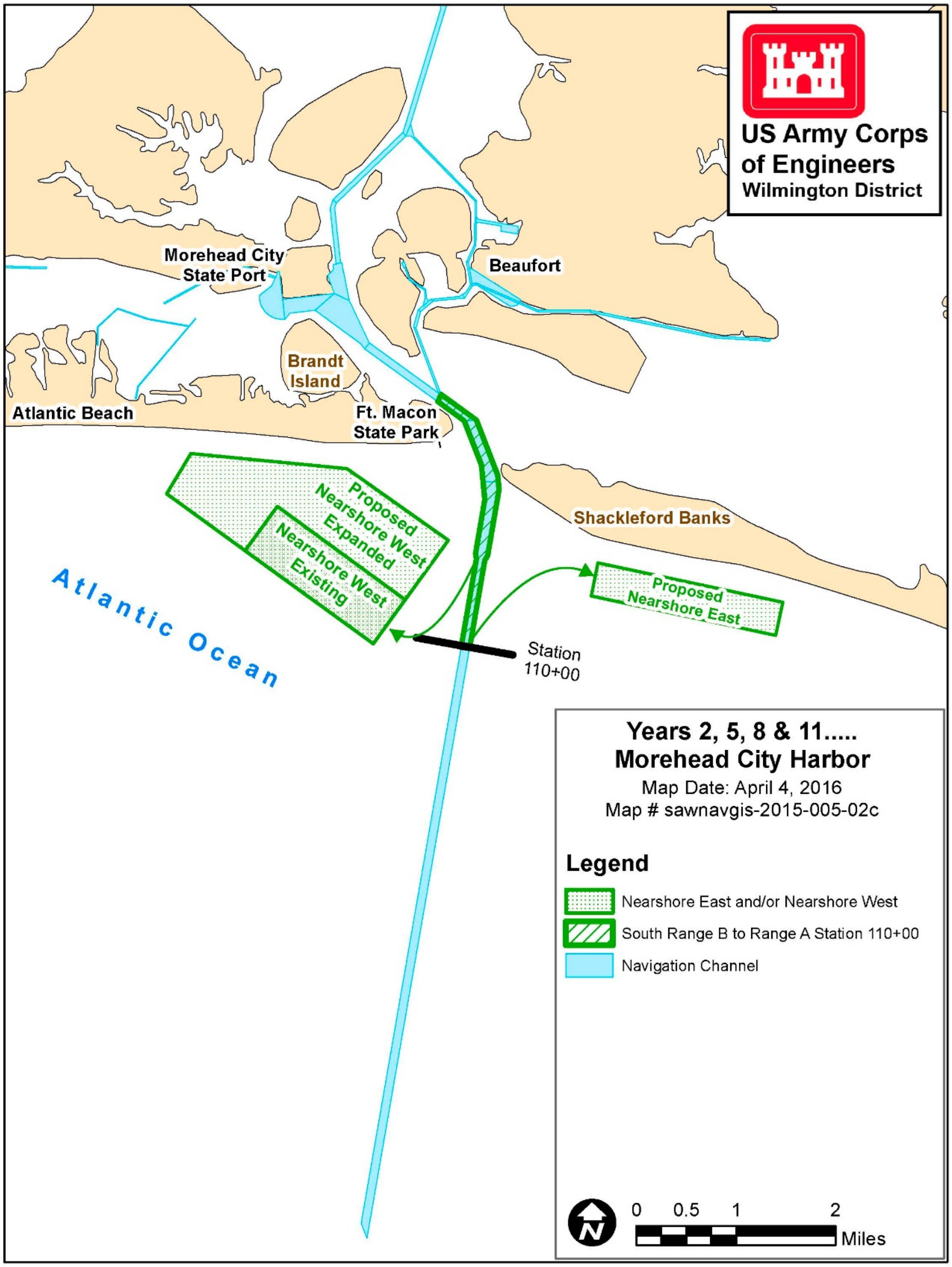


Figure 3. Operations Plan – Years 2, 5, 8,11…..

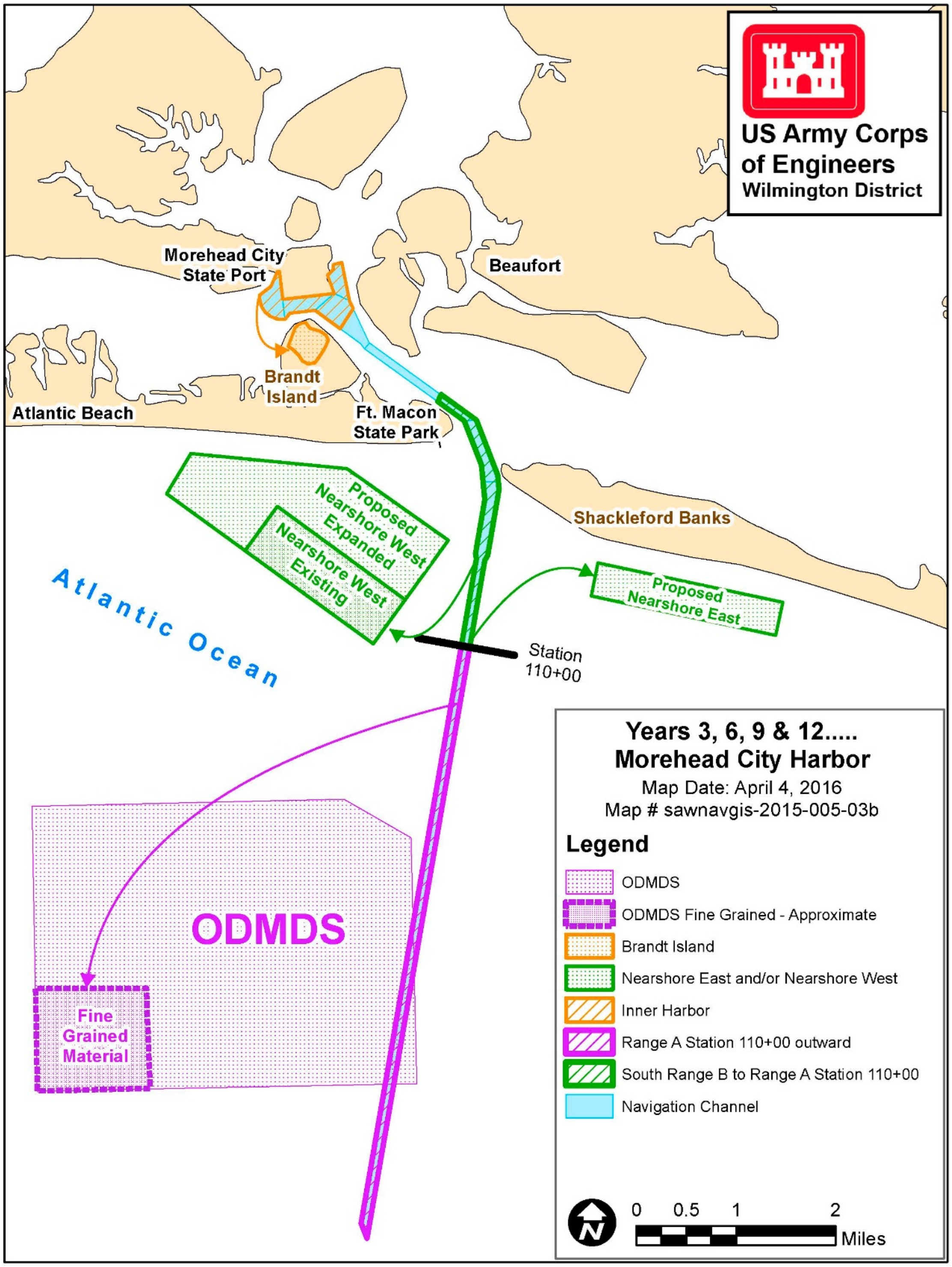


Figure 4. Operations Plan – Years 3,6,9,12………

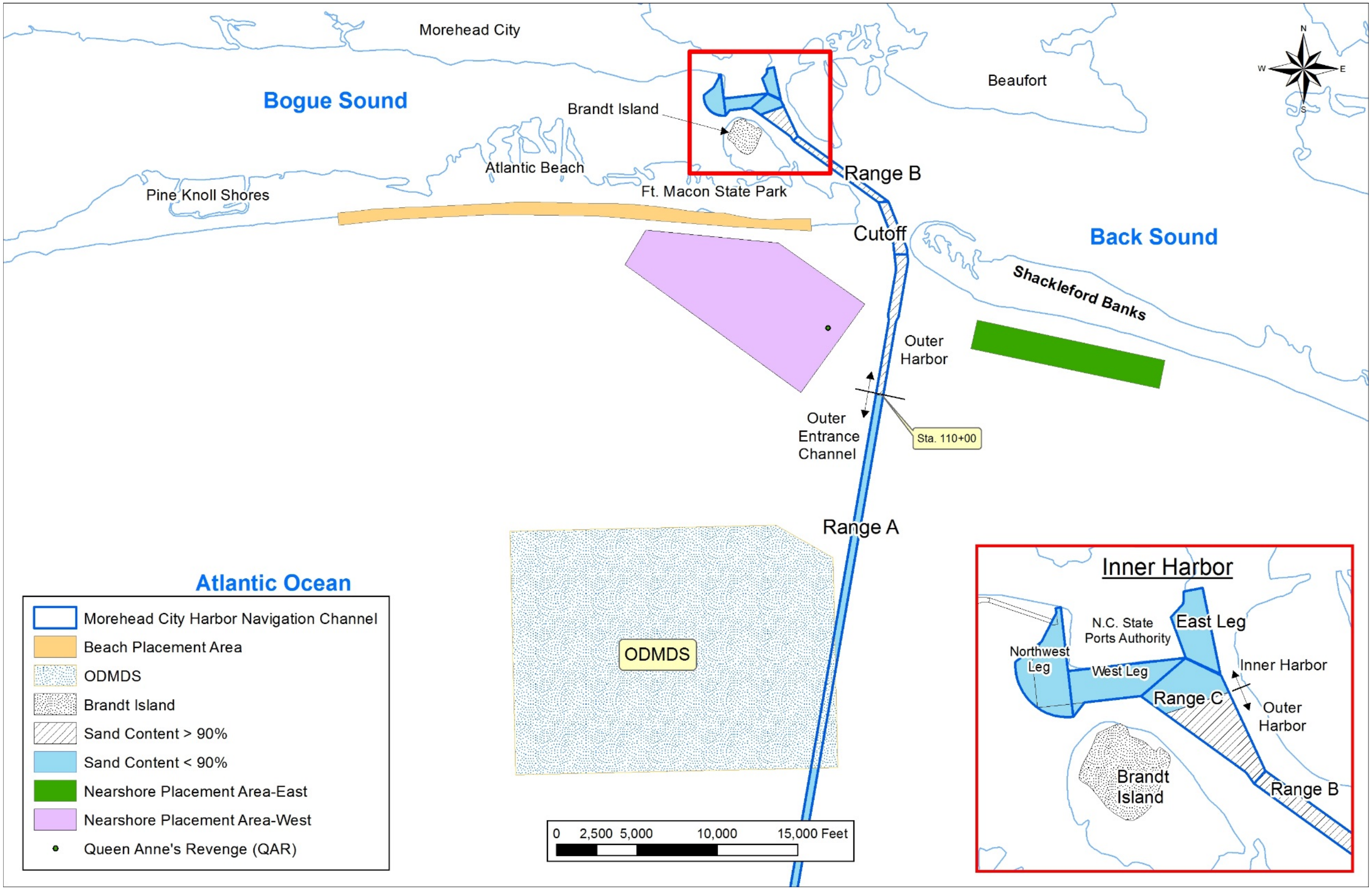


Figure 5. Summary of all Dredging and Disposal Locations

Year 1 of 3-Year Cycle. As shown above in Tables 2 and 3 and Figures 2 through 4, the Outer Harbor reaches would be dredged annually. During the first year of the 3-year cycle, the Outer Harbor ranges (from South Range C out to Station 110+00 of Range A), which contain beach quality material (least 90% sand) would be dredged by an ocean-certified (likely 30-inch) pipeline dredge to fully authorized project depths (45'+ 2 feet of allowable overdepth (45'+2) for most channels, and 47'+2 in Range A), with disposal on the beaches of Fort Macon State Park and Atlantic Beach.

Year 2 of the 3-Year Cycle. During the second year of the 3-year maintenance cycle, a hopper dredge (or pipeline dredge with dump scows or approved direct pipeline method) would be mobilized to dredge the Outer Harbor ranges out to Station 110+00 to fully authorized depths with placement of the beach quality material in the nearshore placement areas. Dredged material quantities to be placed in the nearshore areas will be based on the ratio of the historic losses for the two lobes (west and east) of the ebb tide delta. Approximately 78% of sediment losses occur on the west ebb tide delta and 22% of losses occur on the east ebb tide delta. As project conditions allow, over the next 20 years, material placed within the ebb tide delta will be split between the western and eastern lobes based on this 78/22 ratio. In any one year, it is likely that only one of the nearshore areas will be used. Direct pipeline placement of dredged material in the nearshore areas is proposed as an allowable disposal method, subject to final approval associated with avoidance of impacts to cultural resources.

Year 3 of the 3-Year Cycle. In the last year of the 3-year cycle, the Outer Entrance Channel (Range A from Station 110+00 seaward) would be dredged to a depth of 47'+2 by hopper dredge with disposal in the ODMDS. Sediments in the Outer Entrance Channel are predominantly fine-grained and cannot be disposed of on the beaches or in the nearshore placement areas. The least cost, engineeringly sound, environmentally acceptable alternative for the Outer Entrance Channel sediments is disposal in the ODMDS. Also, in this final year of the 3-year cycle, the Outer Harbor would be dredged again out to Station 110+00 to fully authorized depths, by hopper, pipeline with dump scows or approved direct pipeline method. Outer Harbor dredged material would be placed in the nearshore areas based on the ratios discussed above. Lastly, in year 3 of the maintenance cycle, the Inner Harbor would be dredged by a moderate-sized (likely 18-inch) pipeline dredge or a mechanical (bucket and barge) dredge, with dredged material disposed of either in Brandt Island or in the ODMDS. However, after year 2028, when Brandt Island reaches capacity, all of this Inner Harbor material likely would be disposed of in the ODMDS, within the area designated for fine-grained material.

On infrequent occasions, small quantities of dredged material (typically less than 100,000 cubic yards) that contain at least 90% sand may be disposed of in Brandt Island. This situation is likely to be confined to situations where a small pipeline dredge is maintaining the Inner Harbor, and needs to dredge some quantity of Range C or Range B material that may contain higher sand percentages.

The disposal of all Outer Harbor material will be based on data provided by the Morehead City Harbor Monitoring Plan (Appendix F of the DMMP) and beach placement limits may be modified to best address any shoreline conditions. Additionally, quantities placed would always be subject to navigation priorities and the availability of dredging funds, which may not be sufficient to place quantities equivalent to the historic loss rates. Quantities of material dredged that exceed the annual losses to the ebb tide delta may be available for beach placement on Bogue Banks, by a local entity. Any requests by local entities to place this excess dredged material on the Bogue Banks beaches would be evaluated on a case-by-case basis and the additional costs associated with utilizing the new beach placement area would be funded by the requesting entity through an Additional Work Memorandum of Agreement (MOA).

4.0 Sediment Characteristics

Dredging methods and disposal/placement options for the MHC maintenance-dredged material depend on the channel location and the *in situ* material characteristics. Based on sediment characteristics and potential disposal locations, the deep draft channels or ranges at Morehead City Harbor are grouped into three sections; the Inner Harbor, the Outer Harbor, and the Outer Entrance Channel.

The most recent sediment sampling efforts, which occurred in 2003, 2008 and 2011, indicated that the majority of Inner Harbor material consists of fine-grained material which ranges from 23% to 99% sand with the majority of material being less than 90% sand. As a general rule, placement of dredged material on beaches or in the nearshore is limited to that material which is at least 90% sand. Inner Harbor material is less than 90% sand and therefore not suitable for placement onto adjacent shorelines or in the nearshore. Sampling also showed that the majority of the shoaled material located in the Outer Harbor consists of coarse-grained material suitable for beach or nearshore placement; with the exception of a small amount of material in the Outer Entrance Channel from station 110+00 seaward. Sediment characteristics are shown below in Table 4 and are shown graphically in Figure 6.

Harbor Section	Range	Disposal/Placement Location	Dredge Type	Sediment Classification (% Sand)
Inner Harbor	Northwest Leg	ODMDS/Brandt Island	Bucket/Pipeline	23% to 77%
	West Leg	ODMDS/Brandt Island	Bucket/Pipeline	88% to 94%
	East Leg	ODMDS/Brandt Island	Bucket/Pipeline	40% to 95%
	Partial Range C	ODMDS/Brandt Island	Bucket/Pipeline	80% to 99%
Outer Harbor	Partial Range C	Beach/Nearshore	Pipeline/Hopper	≥90%
	Range B	Beach/Nearshore	Pipeline/Hopper	≥90%
	Cutoff	Beach/Nearshore	Pipeline/Hopper	≥90%
	Range A out to Station 110+00	Beach/Nearshore	Pipeline/Hopper	≥90%
Outer Entrance Channel	Range A, beyond Sta. 110+00	ODMDS	Hopper	47% to 99%

Table 4. Sediment Characteristics of Morehead City Harbor Ranges

Figure 6. Morehead City Harbor Dredged Material Separation Based on Percent Sand

5.0 Shoaling Rates

The purpose of the shoaling analysis is to determine the average amount of material that is shoaling into the navigation channel at Morehead City Harbor on an annual basis. In general, the shoaling rate numbers represent the greatest material volumes that would ever be expected to be dredged from the Morehead City Harbor navigation channel (assumes no funding limitations). For this analysis, the Morehead City Harbor navigation channel is broken into six major ranges as follows:

Range A, Range B, Cutoff, Range C / East Leg, West Leg, and Northwest Leg

To effectively evaluate both future required disposal capacity and project costs, two sets of shoaling rates were used. The full annual shoaling rate was used to ensure adequate future disposal capacity for at least the next 20 years. To more accurately calculate project costs over the next 20 years, a reduced annual shoaling rate was developed. The reduced rate was computed by removing the quantity of material from the annual rate that is typically dredged at no direct cost to the government. Depending on the channel conditions, a contractor may occupy a channel for up to 10 weeks while dredging the channel to a contract template. A significant percentage of the annual shoaling is essentially removed at no direct cost to the Government during this contractor-occupied period. Note that the terms “suitable” and “unsuitable’ in Table 5 refer to the suitability of sediments for beach or nearshore placement.

Range	Shoaling Rate (C.Y./Year)	Avg. Contract Duration* (days) (1997-2008)	Reduction Factor Based on Average Contract Dredged Duration	Representative Shoaling Rate (C.Y./Year) Used for Economic Evaluation
Range A Suitable	630,500	65.0	82.2%	518,000
Range A Unsuitable	118,500	12.2	96.7%	114,500
Range B	171,000	39.5	89.2%	152,500
Cutoff	324,500	70.0	80.8%	262,000
Range C Suitable	80,500	48.5	86.7%	70,000
Range C & East Leg Unsuitable	86,000	48.5	86.7%	74,500
West Leg	28,000	14.0	96.2%	27,000
Northwest Leg	80,000	45.5	87.5%	70,000
* per contract				

Table 5. Dredged Material Quantities Used in Development of the Ops Plan (& DMMP)

6.0 Disposal/Placement Sites

6.1 Brandt Island

Brandt Island is approximately 168 acres in size and located south of the existing Port of Morehead City, across the Morehead City Harbor channel (Figure 1). The Island is divided from the Bogue Banks barrier island by the narrow Fishing Creek; a portion of the island has been used as a disposal area since 1955. Brandt Island is owned by and has previously been used as a sand-recycling site by the North Carolina State Ports Authority (NCSPA). It is currently designated by the NCSPA as a site for MHC Harbor project dredged material disposal. The Brandt Island disposal area encompasses approximately 64 acres of the island and has a present capacity of about 3 million cubic yards.

From 1978 through 2005 the majority of Inner Harbor dredged material was temporarily disposed of in the Brandt Island disposal area and later pumped onto the adjacent beaches of Fort Macon State Park and Atlantic Beach. These beach placements (Brandt Island pumpouts) renourished local beaches and restored capacity in Brandt Island. The last Brandt Island pumpout, which was in 2005, was problematic in that it included placement of an unacceptable amount of fine-grained material onto the beach. This placement of fine-grained material on the beach, along with recent USACE geotechnical investigations, indicates that the Brandt Island disposal area and portions of the Inner Harbor contain material unfit for beach placement. Since 2005, only fine-grained dredged material has been disposed of in Brandt Island and there are no plans for future pumpouts from Brandt Island to any beaches.

Brandt Island is currently being operated in a one-cell configuration with only fine-grained material from the Inner Harbor being disposed of there. The existing Brandt Island disposal area has a controlling top of dike elevation of approximately 37 feet mean sea level (msl). It is assumed that 2 feet of freeboard will be required at all times during disposal operations and water and dredged material will not be allowed above elevation 35 feet msl within the disposal area. The existing available storage volume below elevation 35 feet msl is approximately 3 million cubic yards. It is expected that the existing Brandt Island disposal area will reach capacity in 2029. This is based on disposal of the following approximate quantities: 15,000 cubic yards annually from the non-federal berths, 512,000 cubic yards from the federal channel every 3 years, and 75,000 cubic yards from the Fort Macon Coast Guard Station every 6 years.

Raising the dikes along the current alignment is not economically justified; however, an expanded alignment with dike raises to elevations of 42’, 47’, 52’ and 55’ may be viable and should be considered as the Brandt Island disposal area nears capacity. An expanded dike would have the standard 15-foot top width and 3 horizontal to 1 vertical side slopes. The toe of the expanded dike alignment would be designed to avoid wetlands and to also allow a construction buffer (work area) adjacent to the toe. Specific information for the subsurface investigation, lab testing, dike design, stability analysis and cost estimates are contained in the MHC DMMP.

6.2 Beach Placement Areas

The beach placement areas are shown below on Figure 7. The two areas shown represent the base beach placement area of Fort Macon and Atlantic Beach and the extended beach placement area, which encompasses the entire area of inlet influence (explained below). The base beach placement area would be used for placement of maintenance dredged material from the MHC project. Future beach placement operations along Bogue Banks would be based on the volumetric loss within the area of Atlantic Beach and Fort Macon. It is recommended that future beach placement operations dispose of material primarily between Stations 77 and 107 (Figure 7). Any material in excess of the amount needed to offset losses between stations 77 and 107 could be disposed of farther west in areas that need material. The quantity and location of future placement events will be based on changes observed through the monitoring program and should be sufficient to ameliorate most non-storm induced losses that occur between beach placement operations.

As part of the MHC DMMP process, the Wilmington District identified areas along the adjacent beaches that are influenced by the ebb tide delta of Beaufort Inlet. This zone of influence is used to determine the future placement limits for material dredged from the system, with the intention of maintaining the health of the ebb tide delta and retaining material within the natural inlet sand-sharing system. Figure 7 displays the approximate limits of potential beach placement areas along Bogue Banks. These areas include the "Base Beach Placement Area," which is the least cost option, and the "Extended Beach Placement Area," which is within the Beaufort Inlet area of influence and may be used by non-federal entities for placement of beach quality sand. Quantities of material dredged that exceed the annual losses to Fort Macon or Atlantic Beach or the ebb tide delta may be available for beach placement by a local entity. Any requests by local entities to place this excess dredged material on adjacent beaches would be evaluated on a case-by-case basis and the additional costs associated with utilizing the new beach placement area would be funded by the requesting entity through an Additional Work Memorandum of Agreement (MOA). The excess material would be required to remain within the Beaufort Inlet system and as such, would only be available for placement within the limits shown on Figure 7. Placement of dredged material from the Beaufort Inlet complex west of station 59 on Bogue Banks would remove material from the complex and potentially increase delta deflation and for this reason would not be acceptable.

Figure 7. Proposed Bogue Banks Beach Placement Areas

6.3 Nearshore Placement Areas

The Beaufort Inlet ebb tide delta complex has experienced substantial erosion of approximately 12 million cubic yards since 1974. Without the quantities of material placed in the existing Nearshore West placement area (~6.2 million cubic yards), the total deflation would have been approximately 18.2 million cubic yards. Sand losses occur asymmetrically across the inlet complex, with 78% lost from the west lobe of the ebb tide delta and 22% lost from the east. An understanding of coastal inlet processes suggests that continued erosion of the ebb tide delta complex is likely to impact the adjacent beaches.

In an effort to retain the material dredged from the navigation channel within the littoral system, a nearshore placement area was established in 1995 on the west side of the navigation channel within the Beaufort Inlet ebb shoal (Nearshore West). This existing nearshore placement area is shown below in Figure 8 and is located approximately between 0.65 and 2.0 miles from the shoreline of Fort Macon State Park centered roughly on the 25-foot mean low water (mlw) contour. The currently-authorized nearshore placement area covers approximately 559 acres of sea floor and is a placement location for coarse-grained (beach quality) sand. As part of the DMMP, the Nearshore West will be expanded by approximately 1,209 acres, so the total Nearshore West placement area will consist of about 1,768 acres (Figure 8). Also, shown on Figure 8 is the approximate location of the *Queen Anne's Revenge* (QAR), which is a shipwreck that dates to 1718 and was the primary vessel of the pirate Blackbeard. This site is listed on the National Register of Historic Places and is managed by the N.C. Division of Archives and History. A special restricted zone is in place to protect the QAR from inadvertent project-related damages.

In order to reduce further deflation of the eastern ebb tide delta, a new nearshore placement area is proposed on the east side of Beaufort Inlet. Figure 9 shows the proposed location of the new placement area (Nearshore East), which is located approximately 0.25 miles seaward of the Shackleford Banks shoreline and outside the National Park Service's Cape Lookout National Seashore (CALO) boundary. The CALO boundary ends at the mean low water contour along the Atlantic Ocean shoreline. The Nearshore East Placement area extends from approximately the -17 ft NAVD88 contour to depths of -36 to -40 feet NAVD88 and is approximately 13,300 feet in length. In total, this proposed placement site consists of approximately 1,094 acres.

Material placed within the ebb tide delta will be split between the Nearshore West and Nearshore East Placement Areas based on the 78/22 ratio of sediment losses mentioned above. Over the life of this Ops Plan (20 years), it is Wilmington District's intent to meet this 78/22 ratio, although individual dredging jobs will likely use a single nearshore area. Dredged material quantities will be evaluated through the planned monitoring program and will be adjusted to conform to the evolving conditions of the ebb tide delta.

In order to monitor the evolution of the ebb tide delta and verify anticipated migration of material from the nearshore placement areas to the surrounding ebb tide delta, a monitoring program has been developed and is included as Appendix F of the DMMP. Monitoring is proposed to include semiannual beach profile survey collection, pre- and post-placement surveys of the placement sites within the nearshore placement areas, including a 1000’ buffer around such sites, annual aerial or satellite photography, and surveys of the ebb tide delta lobes once every three years. These data will be evaluated annually and the results of the analyses will be considered in determining future disposal methodology. If monitoring indicates that the nearshore placement areas are becoming too shallow for dredges to access, those areas, pending coordination and environmental review, may be expanded to facilitate continued placement of material in the ebb tide delta.

Existing and Expanded Nearshore West Placement Area

Figure 8. Existing and Expanded Nearshore West Placement Area

Proposed Nearshore East Placement Area

Figure 9. Nearshore East Placement Area

6.4 Morehead City Ocean Dredged Material Disposal Site (ODMDS)

The Morehead City ODMDS (Figure 10) was designated by the U.S. Environmental Protection Agency (EPA) pursuant to Section 102(c) of the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972, as amended, as suitable for the ocean disposal of dredged material effective as of September 1987 (52 FR 30360). The boundary coordinates (NAD 27 Geographic) for the Morehead City ODMDS are:

34^0 38'30" N 76^0 45'00" W
34^0 38'30" N 76^0 41'42" W
34^0 38'09" N 76^0 41'00" W
34^0 36'00" N 76^0 41'00" W
34^0 36'00" N 76^0 45'00" W

The site is located just beyond 3 nautical miles offshore of Bogue Banks, North Carolina. The Morehead City ODMDS has an area of about 8.0 square nautical miles. Depths within the ODMDS range from about -30 to -55 feet mean low water (mlw) based on a composite of bathymetric surveys which include data from 1995 to 2011. Depths are shallowest in the northern (inshore) portion and gradually deepen to the south (offshore). Approximately 60% of the area is greater than -50 feet mlw. The bathymetry is essentially flat except for slight mounds of dredged material in the northeast third and middle of the ODMDS due to previous dredged material discharges and the influence of the Beaufort Inlet ebb tide delta.

Bathymetric surveys have indicated that the sandy and coarse dredged materials historically disposed of within the Morehead City ODMDS have the potential to mound appreciably when specific areas are repeatedly used for disposal. Such mounds may limit future use of specific areas of the ODMDS and may pose impairment to navigation including use by hopper dredges. Project contracts require dredging contractors to prevent such mounding, and the Wilmington District monitors dump locations. The ODMDS will have more than adequate disposal capacity over the next 20 years.

<u>Morehead City ODMDS Site Management</u>**.** As documented in the Site Management and Monitoring Plan (SMMP), dated February 2010 all ocean disposal at the Morehead City ODMDS must be conducted in accordance with the applicable Ocean Dumping Regulations and Criteria found in 40 CFR Parts 220-238, whether conducted as a permit activity or as a federal activity. The disposal quantity management objective for the Morehead City ODMDS is to regulate disposal quantities such that depths in the disposal area following disposal do not interfere with navigation. The disposal depth limitation will be -30 feet mlw. Current average depths in the ODMDS are approximately -45 to -50 feet mlw.

Disposal is typically accomplished by hopper dredge or dump scow. For each disposal project, a specific area within the ODMDS will be designated for use and a specific disposal pattern will be prescribed. Dredged materials disposed of within the ODMDS boundaries shall be discharged at least 600 feet from the ODMDS site boundary. As shown on Figure 10, the northern half of the Morehead City ODMDS is designated for dredged material that is coarse-grained (beach quality, at least 90% sand), making it an accessible source of sand for future beach replenishments, while the southern half is designated for fine-grained material. Beach-quality material was excavated from the Morehead City ODMDS by Carteret County as a borrow source for nourishment of the Bogue Banks beaches in 2004, 2007 and 2013, following Hurricanes Isabel and Ophelia, and Irene, respectively. Future use of dredged material from the ODMDS for beach replenishment is possible, and is encouraged.

Dredged Material Evaluation. Only dredged materials which have been evaluated in accordance with USEPA's Ocean Dumping Regulations and Criteria and found in compliance with those criteria will be transported for disposal in the Morehead City ODMDS. The determination of dredged material suitability for ocean disposal must be documented in a MPRSA Section 103 evaluation and approved by USEPA Region 4 prior to disposal. Only one non-federal maintenance dredging and ocean dredged material disposal permit (permitted pursuant to Section 103 of MPRSA) has taken place in the Morehead City Harbor area, that being associated with the State maintained portions (berths) of the North Carolina State Ports Authority. Dredged materials will be reevaluated for suitability for ocean disposal in accordance with current USACE/USEPA guidance at an interval not to exceed three years.

Dredged Material With Debris. If significant quantities of debris (either wood or man-made) are present in the dredged materials, then debris management should be conducted. Significant quantities of debris are considered to be those which would materially interfere with fishing in areas near the Morehead City ODMDS or interfere with re-use of dredged material from within the ODMDS (i.e., beach nourishment borrow material). Debris management may involve the following:

- Removal of the debris from the dredged material before transportation to the ODMDS;
- Disposal of dredged material in the ODMDS in a location (e.g., farthest distance possible from the fishing areas or borrow areas) such that debris interference is unlikely;
- Immobilizing the debris within the ODMDS by covering it (capping) with dredged material.

Timing of Disposal. There are no seasonal restrictions on the disposal of dredged material within the Morehead City ODMDS. However, seasonal restrictions and seasonal special requirements apply to particular dredging activities at particular locations. Refer to Section 8 for a discussion of dredging windows.

Channel Area. If the alignment of the Morehead City Harbor Range A channel is extended seaward, it crosses the eastern border of the ODMDS. In order to provide safe navigation, dredged material disposal will not be allowed within approximately 1000 feet of the current limits of channel dredging. This area where the navigation channel intersects the ODMDS is shown on Figure 10. Disposal of dredged material in this area will be allowed only after a review by Wilmington District USACE in consultation with USEPA Region 4 and only if a determination is made that the proposed disposal will specifically not interfere with navigation.

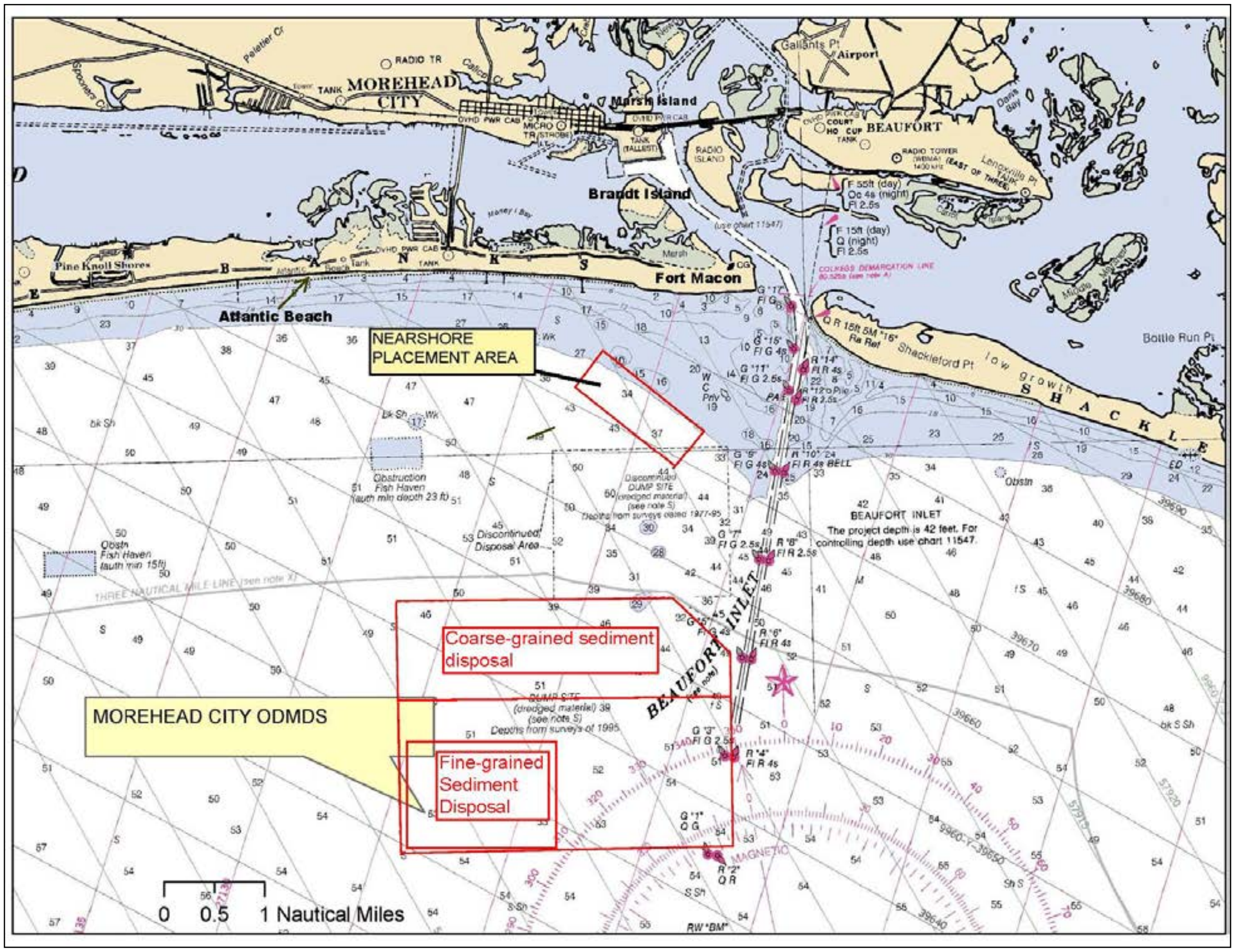


Figure 10. MHC ODMDS in Relation to Channel and Existing Nearshore West

7.0 Compliance with the Federal Standard

Pursuant to 33 C.F.R. § 335.7, federal standard means the dredged material disposal alternative or alternatives identified by the Corps, which represent the least costly alternatives consistent with sound engineering practices and meeting the environmental standards established by the Clean Water Act Section 404(b)(1) evaluation process or ocean dumping criteria. The base plan identified in this Operations Plan provides the least cost, engineeringly sound, environmentally acceptable alternatives for disposal of maintenance dredged material from Morehead City Harbor and therefore meets the federal standard.

An important component of the proposed plan is beneficial use of dredged material by placement on adjacent beaches and in ebb tide delta locations at regular intervals to ameliorate the possible losses of material from these areas caused by dredging the navigation channel. Because the cutoff region of the channel is characterized by extremely steep slopes, which requires the use of costly cutter head dredging equipment and the location of this section is very close to the beach, beach placement is the most effective and efficient method of placement for that material. Costs and shoaling rates make a three-year cycle the most optimal alternative for beach placement of this material. Other reaches of the channel are best maintained by hopper dredges, and for those reaches, nearshore placement is the alternative that best meets the federal standard. While ODMDS disposal of beach-quality dredged material is the least cost alternative for most channel reaches, the long-term effects of ODMDS-only disposal to inlet stability, adjacent shorelines, and biological communities makes it both engineeringly and environmentally less preferable than alternatives that keep most of the sand in the inlet sand-sharing system.

8.0 Environmental Compliance and Commitments

In October 2013, the Draft DMMP/EIS was provided to a standard list of federal, state, and local agencies, elected officials, environmental groups, and known interested individuals for a 45-day review and comment period. All input received was considered during the preparation of the Final DMMP and the Operations Plan.

Upon completion of the NEPA process for the DMMP, all clearances and approvals will be in place to execute this Operations Plan. This Operations Plan is fully consistent with the State's Coastal Management Plan (CMP), which states that clean, beach-quality material from navigation channels within the active nearshore, beach, or inlet shoal systems must not be removed permanently from the active nearshore, beach or inlet shoal system unless no practicable alternative exists (15A NCAC 07M.1102, Section 1102). The Wilmington District may allow dredge captains the discretion to place dredged material in the ODMDS when those captains believe that sea and weather conditions prohibit safe operation within the nearshore placement areas. Other ODMDS disposal of beach-quality material will only occur on a case-by-case basis after appropriate coordination, when other disposal methods have been determined to be impracticable. Implementation of the proposed plan would result in approximately 79% of the dredged material from the Morehead City Harbor project being beneficially used. A consistency determination for the 20-year plan will be issued prior to completion of the NEPA process for the DMMP.

The following commitments apply to implementation of this Plan:

1. Adherence to environmental windows, which include:

   - Hopper dredging: No window is required; however, the Wilmington District will consider scheduling hopper dredge activities from January 1 to March 31 in order to minimize dredging impacts on sea turtles.
   - Bucket and barge dredging: No window is required except in the Inner Harbor (Northwest, West and East Legs), which has a window of August 1 to March 31.
   - Pipeline dredging: No window is required.

- Disposal: November 16 to April 30 for beach placement on Bogue Banks (Endangered Species Act); September 1 to March 31 for disposal on Brandt Island, if nesting birds are present; if birds are not nesting, there is no window.
- No window for placement of material in the Nearshore West or Nearshore East is proposed.

Every reasonable effort will be made to accomplish maintenance of the Morehead City Harbor project within these windows. Should circumstances require that work be accomplished outside of the aforementioned windows, the Wilmington District will communicate/coordinate the action with all appropriate resource agencies prior to start of work.

2. If escarpments occur on the beach after placement, the escarpment will be graded prior to the sea turtle nesting season during any given year in order to permit sea turtle nesting on the beach.

3. Should a hydraulic pipeline dredge be used offshore, the pipeline from the navigation channels to the placement beach will be submerged until it reaches nearshore waters. The pipeline would be marked to let commercial and recreational boaters know of its presence along the bottom. Work barges and other appurtenances associated with a pipeline dredge operating in open water would be moored so as to minimize interference with boat traffic in the area. A specific zone has been identified for submerged pipeline placement that avoids cultural resources.

4. Surveys of the project area for seabeach amaranth will be conducted prior to any placement operation (construction) from 1 July to September 30 of any year.

5. Within Morehead City Harbor, some of the navigational channels are closed to shellfish harvesting. If maintenance material is excavated from these closed shellfishing areas between May 1 and October 31 and disposed of on Bogue Banks, a swimming advisory will be posted and a press release made. The Wilmington District will notify the Shellfish Sanitation and Recreational Water Quality Section prior to dredging from a closed shellfishing area with placement on a recreational swimming area.

6. If anchoring in the nearshore placement areas is required, cultural resources exclusion areas will be avoided.

7. Dredged materials disposed of within the ODMDS boundaries shall be discharged at least 600 feet from the ODMDS site boundary. Also, dredged material disposal will not be allowed within approximately 1000 feet of the current limits of channel dredging.

8. Disposal quantities in the ODMDS will be regulated so that water depths following disposal do not interfere with navigation. The disposal depth limitation will be -30 feet mlw.

Implementation of this proposed Operations Plan is not expected to result in any significant adverse environmental effects. Significant resources (including terrestrial and marine biota, cultural resources, threatened and endangered species, air and water quality, socio-economics, esthetics, and recreation) will not be adversely impacted. Approvals and clearances, including compliance with the State's CMP and Section 103 of the Marine Protection, Research, and Sanctuaries Act (Ocean Dumping Act) of 1972, will be updated as required, which is typically every 3 years.

9.0 Conclusion

This Operations Plan attempts to maximize beneficial uses of dredged material within the requirements of the federal standard. Coarse-grained (beach-quality) dredged material would be disposed of on the beaches of Fort Macon State Park and Atlantic Beach, or in the nearshore placement areas to replenish the deflated ebb tide delta. Fine-grained dredged material would be disposed of in Brandt Island or the ODMDS.

The three-year dredging cycle assumes that funding will be available to dredge and monitor as planned, appropriate dredge equipment will be available, and that unexpected shoaling would not occur. The three year rotational cycle is the base plan, but must remain flexible and adjustable to meet the navigation needs of the Morehead City Harbor navigation project, therefore, from time to time, the cycle may be adjusted, resulting in fewer dredging events and dredged material quantities that differ from those described in this Ops Plan. Nothing in this document should be read to suggest that material will be dredged for the purpose of placement on the beaches or in the nearshore, or for any purpose other than addressing navigation priorities.

1 DMMP STUDY BACKGROUND

1.1 Purpose and Need

The U.S. Army Corps of Engineers (USACE) Engineer Regulation (ER) 1105-2-100 provides that the USACE Districts develop a Dredged Material Management Plan (DMMP) for all Federal harbor projects where there is an indication of insufficient disposal capacity to accommodate maintenance dredging for the next 20 years.

In 1997, a Preliminary Assessment (PA) for Morehead City Harbor was completed by the USACE, Wilmington District. The purpose of the PA was to document the continued viability of the Port and to determine whether there is dredged material disposal capacity sufficient to cover at least 20 years of maintenance dredging. The PA concluded that there were no significant problems to the continued maintenance of the Morehead City Harbor project; therefore, a DMMP was not recommended at that time. However, since 1997, changes have occurred regarding the management of dredged material from Morehead City Harbor. In the past, capacity in the Brandt Island confined disposal site was periodically restored when the material from the Brandt Island site was pumped to the beach. Because pumpouts are no longer a feasible option, since 2005 (the last pumpout), only fine-grained material has been disposed of in Brandt Island. These changes are discussed in more detail in Section 2.1 (Existing Conditions). To address these changes and the implications for future management of the Harbor, development of a formal dredged material management plan is now warranted. The DMMP meets the requirements of ER 1105-2-100.

1.2 Authority and Scope

The U. S. Army Corps of Engineers (USACE) Appendix E, Section II, paragraph E-15 of ER 1105-2-100 provides that a DMMP be developed for federal navigation projects if a Preliminary Assessment does not demonstrate sufficient capacity to accommodate maintenance dredging for the next twenty years. The DMMP is a planning document that ensures maintenance dredging activities are performed in an environmentally acceptable manner, use sound engineering techniques, and are economically justified. A DMMP addresses dredging needs, disposal capabilities, capacities of disposal/placement areas, environmental compliance requirements, potential for beneficial use of dredged material, and indicators of continued economic justification. Beneficial use is defined as utilizing dredged sediments as resource materials in productive ways. Dredged Material Management Plans ensure that sufficient disposal capacity is available for at least the next 20 years and should be updated periodically to identify any changed conditions.

In addition to ER 1105-2-100, three policy guidance memoranda provide additional guidance regarding the preparation of DMMPs. They are: 1) Policy Guidance Letter (PGL) No. 40, dated March 1993, Development and Financing of Dredged Material Management Studies; 2) PGL No. 42, dated March 1993, Additional Guidance on

Financing of Dredged Material Management Studies; and 3) PGL No. 47, dated April 1998, Cost Sharing for Dredged Material Disposal Facilities and Dredged Material Disposal Facility Partnerships.

Pursuant to PGL 40, the federal interest in continued operation and maintenance of an existing federal project for its navigation purpose is the base disposal plan (“base plan”), which is defined as the least cost plan for dredged material management that is consistent with sound engineering practice and meeting the environmental standards established by Section 404 of the Clean Water Act of 1972 or Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972, as amended. Pursuant to 33 CFR 335.4, USACE undertakes operations and maintenance activities where appropriate and environmentally acceptable. All practicable and reasonable alternatives are fully considered on an equal basis. This includes the discharge of dredged or fill material into waters of the U.S. or ocean waters in the least costly manner, at the least costly and most practicable location, and consistent with engineering and environmental requirements. Each management plan must establish this base plan using the procedures in 33 CFR Parts 334, 335, 336, and 337.

Federal funds for DMMP studies are limited to establishment of the base plan. However, pursuant to ER 1105-2-100, all dredged material management studies are required to include an assessment of potential beneficial uses for environmental purposes including fish and wildlife habitat creation, ecosystem restoration and enhancement, and/or hurricane and storm damage reduction. Study activities related to dredged material management for the federal project, but not required for continued maintenance dredging and dredged material disposal, will not be included in management plan studies unless funded by others (Appendix E, ER 1105-2-100). Therefore, studies of measures beyond establishment of the base plan are outside the scope of this DMMP. Those types of studies, as specifically mentioned where applicable throughout the text of this DMMP, may be pursued through other subject-specific authorities.

The Morehead City Harbor federal navigation project is the subject of this DMMP. Details regarding the Morehead City Harbor project authority and history are provided below in Section 2.1 (Existing Conditions).

1.3 DMMP Process

The DMMP for the Morehead City Harbor project has been developed using a consistent and logical procedure by which dredged material management measures and alternatives have been identified, evaluated, screened, and recommended so that dredged material disposal operations are conducted in a timely, environmentally sensitive, and cost-effective manner. The overall framework for the Morehead City Harbor DMMP development is shown below in Figure 1-1.

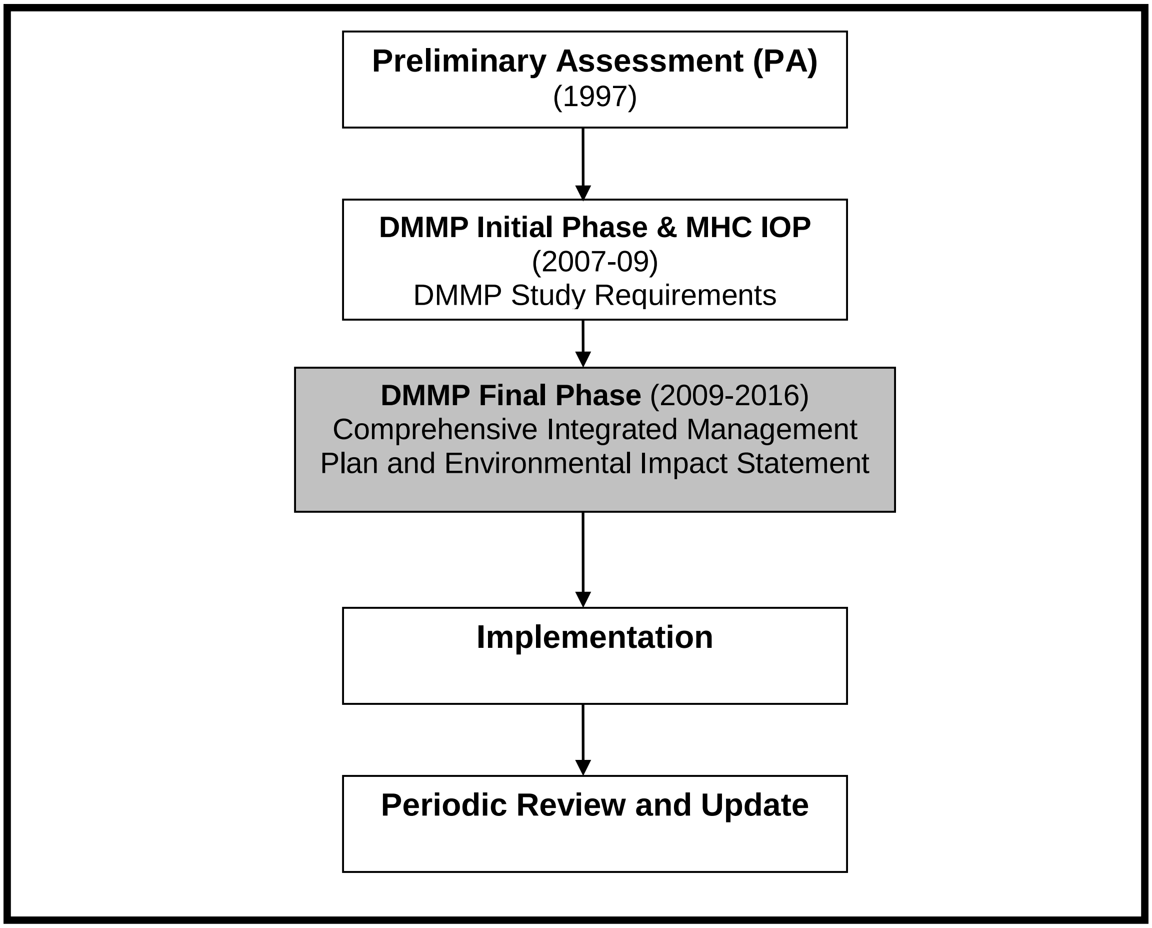


Figure 1-1. Morehead City Harbor DMMP Framework

As discussed above, due to changes in disposal practices for maintenance dredged material from Morehead City Harbor, development of a formal dredged material management plan is warranted. The initial phase of the DMMP began in 2007 and included the identification of dredged material management problems and opportunities, the procedure used to identify measures, the methodology used to select measures for further analysis, work tasks, and the costs and schedule to perform those tasks. During this phase an integrated Interim Operations Plan (IOP) and Environmental Assessment and Finding of No Significant Impact (EA/FONSI) were completed for Morehead City Harbor (USACE 2009). The purpose of the IOP was to address modifications to the existing Morehead City Harbor dredged material disposal practices for an interim period while the Morehead City Harbor DMMP was being developed. The final phase of the Morehead City Harbor DMMP began in the winter of 2009 and the final product of this phase is an integrated DMMP and Environmental Impact Statement. Subsequent phases of the DMMP process include implementation of the DMMP with periodic review and update.

1.4 Study Area Description and Location

Morehead City Harbor is a federal navigation project located in the Town of Morehead City, North Carolina, approximately 3 miles from the Atlantic Ocean through Beaufort Inlet (Figure 1-2). The authorized Morehead City Harbor project is divided into two parts: The deep-draft portion and the shallow-draft portion. As shown on Figures 1-3 and 1-4, the deep draft portion consists of three main ranges or sections: 1) the Inner Harbor, which includes the Northwest, West, and East Legs and the northern portion of Range C; 2) the Outer Harbor, which includes the southern portion of Range C, Range B, the Cutoff and Range A out to Station 110+00; and 3) the Outer Entrance Channel, which is made up of the seaward end of Range A (from station 110+00 out). The shallow draft portion includes 3 additional ranges: Range 2, the Basin, and Range 4. In addition to the Morehead City Harbor navigation channels, the DMMP study area also includes the adjacent mainland area, the beaches of Bogue Banks and Shackleford Banks, the nearshore Atlantic Ocean off of Bogue Banks and Shackleford Banks (ebb tide delta) including the current nearshore placement area, the Environmental Protection Agency (USEPA) designated Ocean Dredged Material Disposal Site (ODMDS), and the existing disposal sites on Brandt Island, Marsh Island and Radio Island (Figures 1-3 through 1-5).

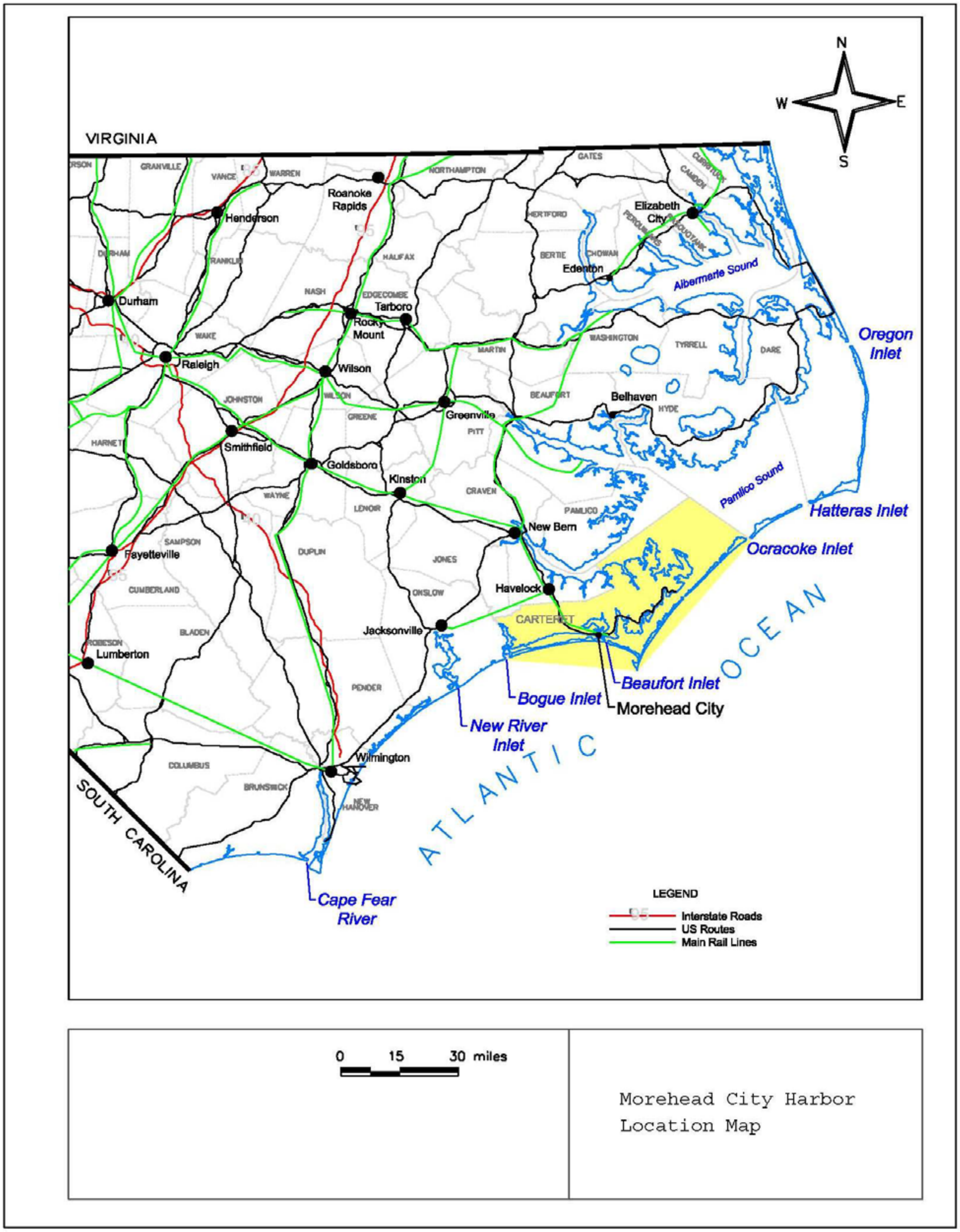


Figure 1-2. Morehead City Harbor Location Map

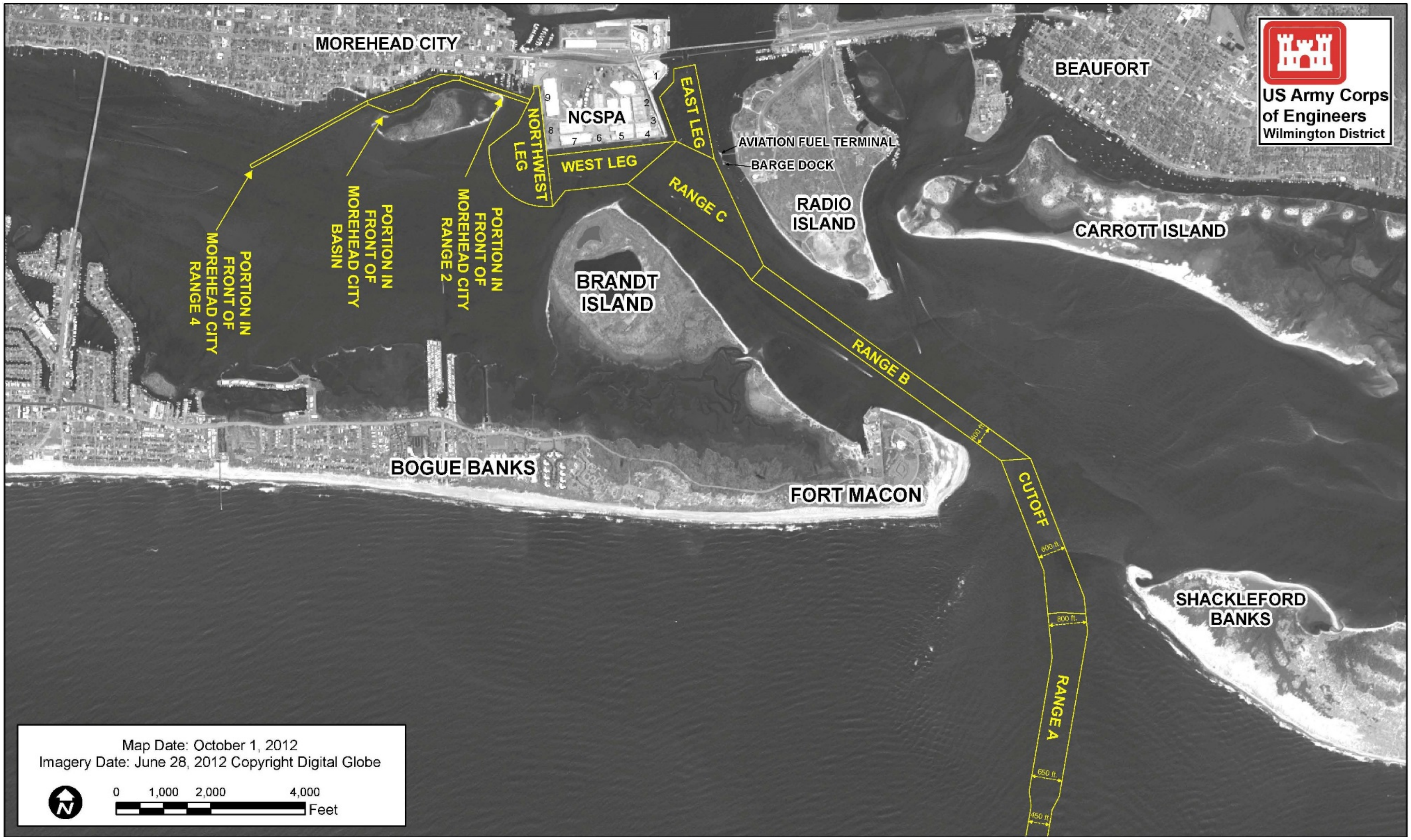


Figure 1-3. Morehead City Harbor Navigation Project

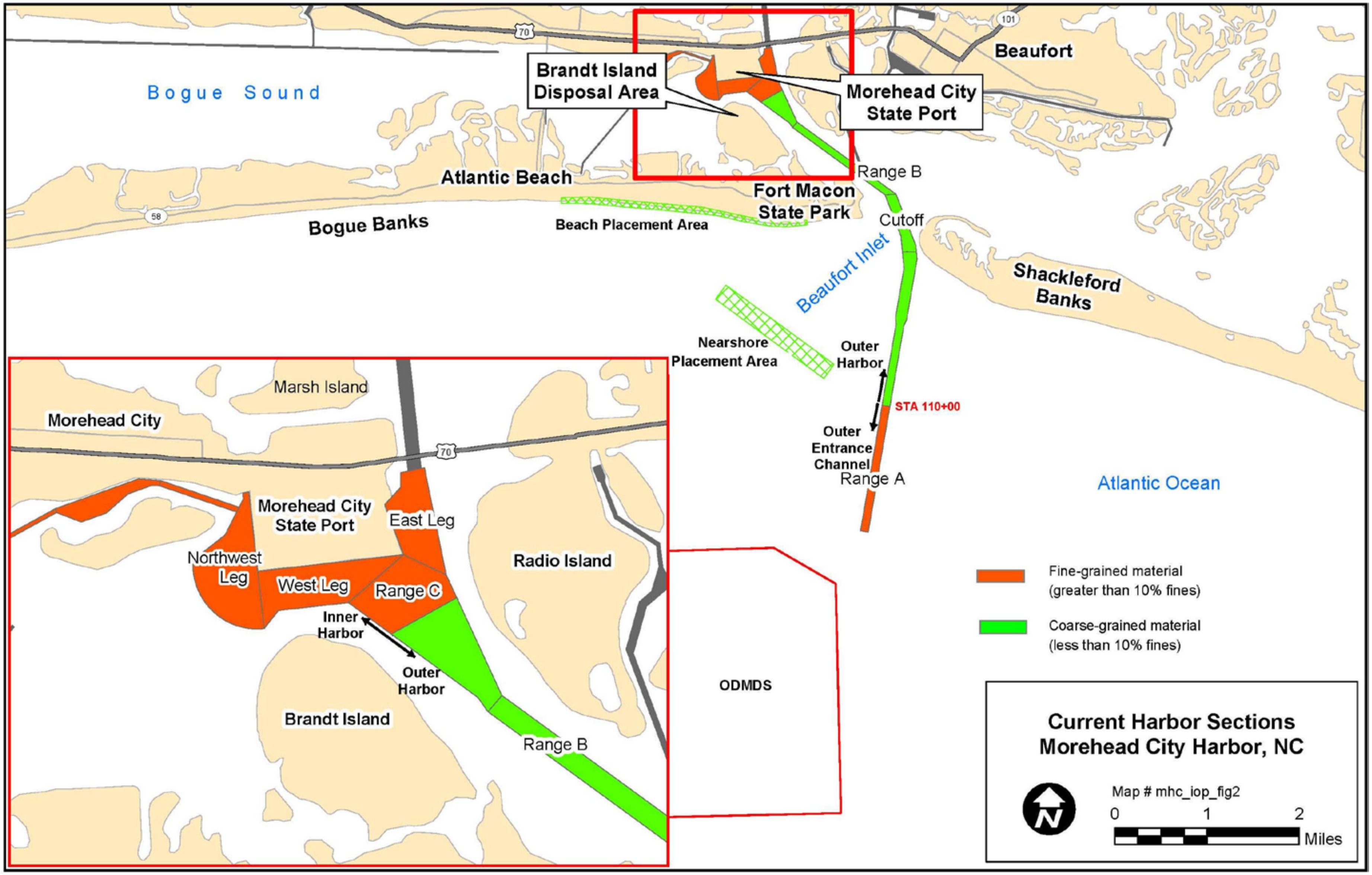


Figure 1-4. Current Harbor Sections, Morehead City Harbor, NC

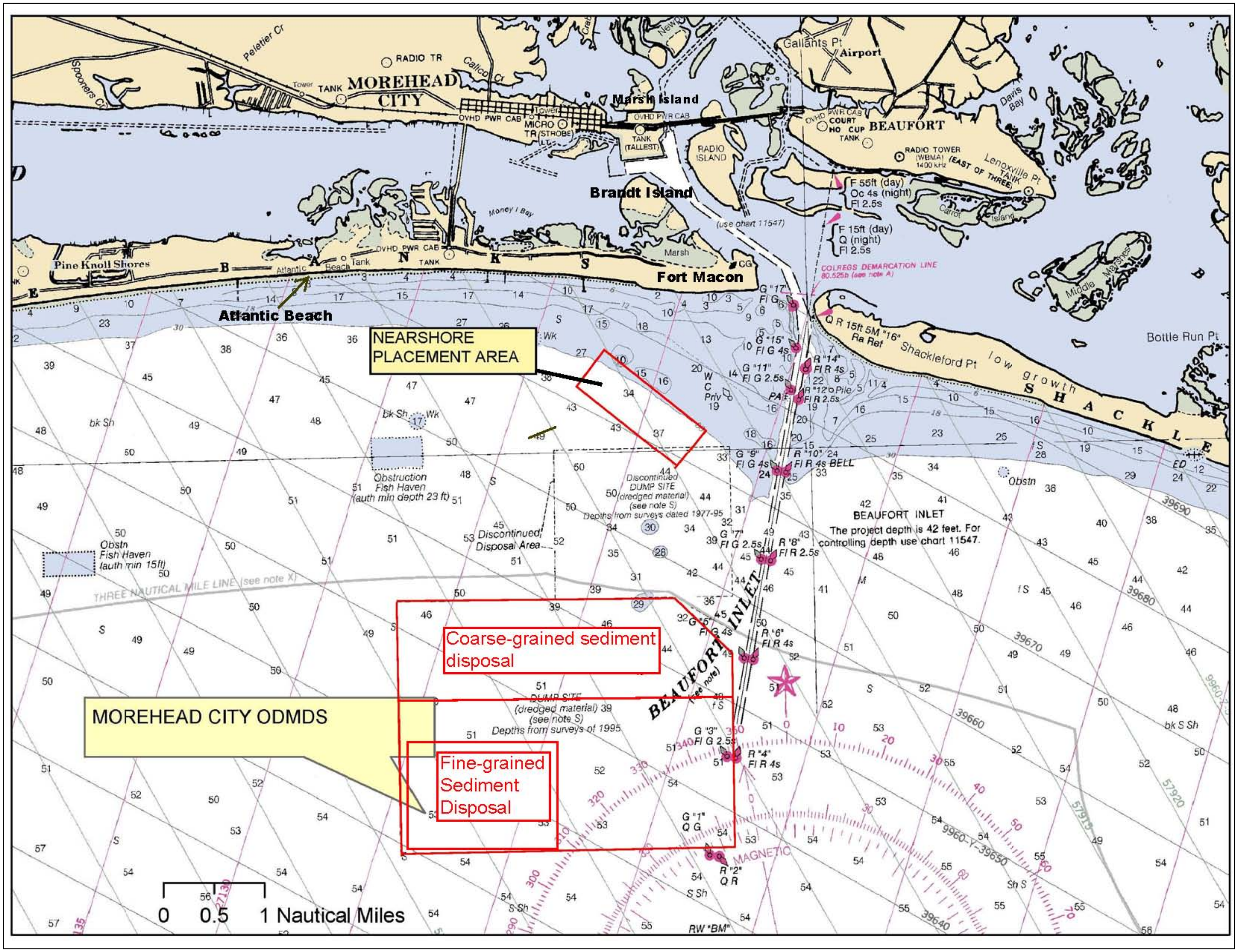


Figure 1-5. Morehead City Harbor DMMP Study Area

1.5 Incorporation by Reference

The USACE has produced a number of environmental and planning reports which describe the Morehead City Harbor federal navigation project, its past improvements, the details of dredging and disposal operations required for its maintenance, and the environmental aspects of the project. These documents (i.e., items a to l below) were used in the writing and development of the DMMP and are cited in the References in Section 13 . Eleven of these reports, which contain extensive background information, are listed below and are incorporated by reference.

a. U.S. Army Corps of Engineers, Wilmington District. May 1976. Final Environmental Statement, Morehead City Harbor, North Carolina.

b. U.S. Army Corps of Engineers, Wilmington District. May 1976. Morehead City Harbor, North Carolina, General Design Memorandum.

c. U.S. Army Corps of Engineers Wilmington District. October 1983. Morehead City Harbor Beach Disposal, Carteret County, North Carolina, Environmental Assessment.

d. U.S. Army Corps of Engineers, Wilmington District. June 1990 and revised December 1990. Feasibility Report and Environmental Assessment, Morehead City Harbor Improvement, Morehead City, North Carolina.

e. U.S. Army Corps of Engineers, Wilmington District. March 1992. Environmental Assessment and Finding of No Significant Impact, Design Memorandum, Morehead City Harbor Improvement, Morehead City, North Carolina, Project Modifications.

f. U.S. Army Corps of Engineers, Wilmington District. January 1993a. Environmental Assessment and Finding of No Significant Impact, Disposal of Dredged Material on the Ocean Beach of Bogue Banks from the Combined Maintenance Dredging and Deepening of Morehead City Harbor Inner Harbor Navigation Channels and Pumpout of Brandt Island Upland Diked Disposal Site, Carteret County, North Carolina.

g. U.S. Army Corps of Engineers, Wilmington District. April 1993b. Finding of No Significant Impact, Disposal of Dredged Material on the Ocean Beach of Bogue Banks from the Combined Maintenance Dredging and Deepening of Morehead City Harbor, Inner Harbor Navigation Channels, Bulkhead Channel, U.S. Navy Landing Ship Tank (LST) Ramp, and Pumpout of Brandt Island Upland Diked Disposal Site, Carteret County, North Carolina.

h. U.S. Army Corps of Engineers, Wilmington District. August 1994a. Environmental Assessment, Designation and Use of a Placement Area for Underwater Nearshore Berm, Morehead City Harbor Project, Morehead City, North Carolina.

i. U.S. Army Corps of Engineers, Wilmington District. December 1994b. Finding of No Significant Impact, Designation and Use of a Placement Area for Underwater Nearshore Berm, Morehead City Harbor Project, Morehead City, North Carolina.

j. U.S. Army Corps of Engineers. 2001. "Section 111 Report, Morehead City Harbor/Pine Knoll Shores North Carolina", U.S. Army Corps of Engineers, Wilmington District, South Atlantic Division

k. U.S. Army Corps of Engineers, Wilmington District. May 2003. Draft Evaluation Report and Environmental Assessment, Morehead City Harbor Section 933, Carteret County, North Carolina.

l. U.S. Army Corps of Engineers, Wilmington District. June 2009. Environmental Assessment and Finding of No Significant Impact, Interim Operations Plan. Morehead City Harbor, North Carolina.

The Integrated DMMP and EIS will provide information that is immediately pertinent to the new proposed actions and will not repeat the information incorporated by reference.

2 DESCRIPTION OF EXISTING CONDITIONS, FUTURE WITHOUT PROJECT CONDITIONS, PROBLEMS, OPPORTUNITIES, ASSUMPTIONS, GOALS, AND CONSTRAINTS

2.1 Existing Conditions

Physical Harbor Conditions. Construction of Morehead City Harbor was originally authorized by the 1910 Rivers and Harbors Act (Public Law 61-264. The original authorization allowed for construction of a navigation channel 10 feet deep by 100 feet wide through Beaufort Inlet to the Morehead City Waterfront; thence a channel 10 feet deep by 200 feet wide along the Morehead City wharves. Congress modified the authorized channel dimensions several times, including expansion of the project to provide navigation channels and turning basins which service the North Carolina State Ports Authority (NCSPA) facilities, by the following Acts: River and Harbor Act of 1930 (Public Law 71-520); River and Harbor Act of 1937 (Public Law 75-392); River and Harbor Act of 1958 (Public Law 85-500); River and Harbor Act of 1970 (Public Law 91-611); Section 1002 of the Water Resources Development Act of 1986 (Public Law 99-662); Section 101(14) of the Water Resources Development Act of 1992 (Public Law 102-580); and Section 553 of the Water Resources Development Act of 2000 (Public Law 106-541).

The current federal authorization for the Morehead City Harbor project consists of both deep-draft and shallow-draft portions. The deep-draft portion of the project provides navigation channels from the deep water of the Atlantic Ocean to the NCSPA facilities. The shallow draft portion of the project provides for navigation channels from the waterfront docks at Downtown Morehead City to the deep-draft portion of the project. All channels within the Morehead City Harbor project are shown on Figure 1-3. The average tidal range in the Harbor, which is the vertical difference between high tide and the succeeding low tide, is about 3.1 feet.

In addition to the federally-maintained navigation channels, the State of North Carolina (Project Sponsor) is responsible for maintenance dredging within the non-federal berthing areas. Non-federal berthing Areas 1-3, 4-7 (NCSPA), Barge Dock and Aviation Fuel Terminal are shown on Figure 1-3. Berths 8 and 9 are part of the federally-authorized project and therefore are federally maintained. The principal user of these berths is the U. S. Military. All berthing areas (federal and non-federal) were considered during development of the DMMP.

Morehead City Harbor, NC – Deep Draft portion (Outer Harbor & Outer Entrance Channel)

Range A:	47-ft deep mean lower low water (mllw) by 450 to 650 feet wide from deep water in the Atlantic Ocean to Beaufort Inlet; step cut as shown in Figure 1-3.
Cutoff:	45 feet deep mllw with varying width; connecting Range A with Range B.
Range B:	45 feet deep mllw by 400 feet wide; connecting the Cutoff Channel with Range C.

Morehead City Harbor – Deep Draft portion – Inner Harbor

Range C:	45 feet deep mllw by varying width of approximately 400 to 1,350 feet; connecting Range B with East and West Legs. (includes a turning basin in Range C and a portion in the West Leg that is 1,350 feet in diameter);
East Leg:	45 feet deep mllw by a varying width of approximately 800 to 1,000 feet; connecting Range C with the non-federal berthing area, located east of the NCSPA facility.
West Leg:	35 feet deep mllw by approximately 780 feet wide; connecting Range C with the non-federal berthing area, located south of the NCSPA facility and with the Northwest Leg.
Northwest Leg:	35 feet deep mllw by approximately 1,200 feet wide; Note: Federal authorization of the Northwest Leg extends to the West facing bulkhead of the NCSPA facility (i.e., there is no non-federal berthing area located west of the NCSPA facility).

Morehead City Harbor, NC – Shallow Draft portion (in front of Morehead City)

Range 2:	12 feet deep mllw by 100 feet wide from the Northwest Leg to Sixth Street along the Morehead City Waterfront
Basin:	12 feet deep mllw by 200 to 400 feet wide from Sixth Street to 10th Street along the Morehead City Waterfront
Range 4:	6 feet deep mllw by 75 feet wide from 10th Street to the Atlantic Intracoastal Waterway in Bogue Sound

As shown in Figures 1-3 and 1-4, and described above, the Morehead City Harbor navigation project consists of several navigation channels or ranges. Dredging methods and disposal options within each range depend on the channel location and the *in situ* material characteristics. Based on these sediment characteristics and potential disposal locations, in the past the channels or ranges are grouped into sections based on two categories of dredged material: 1) fine-grained material less than 90% sand (not suitable for beach disposal); and 2) coarse-grained material greater than or equal to 90% sand (suitable for beach disposal). The Inner Harbor (Northwest Leg, West Leg, East Leg and North Range C) and the Outer Entrance Channel (Range A, beyond Station 110+00) contain fine-grained material, and the Outer Harbor (South Range C, Range B, Cutoff, Range A out to Station 110+00) contain the course-grained material that is suitable for beach placement.

Below is a summary of current dredging methods and disposal locations for maintenance dredging activities within the Harbor. Table 2-1a, below, contains a summary of all maintenance dredging activities for the deep-draft portion of the Harbor from 1997 to 2008. The shallow-draft portion of the Morehead City Harbor has not been dredged in over 15 years and does not require regular maintenance; therefore, the table below does not include these ranges. Although these shallow-draft channels were considered during the development of alternatives for the DMMP, they are dredged so infrequently and contain such small quantities relative to overall project quantities (~50,000 cubic yards of fine-grained material and ~50,000 cubic yards of coarse-grained sand per 20-year dredge event) that they were not included in the detailed analyses conducted for all other portions of the Harbor. Table 2-1a includes dredging and disposal methods, sediment volumes, dredging frequency, and sediment classification for the various Morehead City Harbor ranges. Sediment classification is based on the Unified Soils Classification System. Sand is described as a material where 50% or more of the material lies between the number 4 sieve (4.76 mm) and the number 200 sieve (0.074mm). Sand removed from navigation channels is acceptable for beach disposal when it has 10% or less passing the number 200 sieve. Table 2-1 lists the Harbor sediment characteristics (% sand) by range.

Table 2-1b, below, includes a summary of MHC Harbor maintenance dredging activities from 2009 to present, the period of time the Interim Operations Plan has been in use. Since 2009, on average, approximately $10.7 million has been received annually for maintenance of MHC Harbor. As demonstrated in Table 2-1b, on four occasions since 2009, no awardable bids were received for maintenance of the MHC navigation project. This was due to the limited funding coupled with lack of availability of dredges in the winter months.

Harbor Section	Range	Estimated Dredging Quantity (Cubic Yards/Year)	Frequency of Dredging (years)	Disposal/Placement Location	Dredge Type	Sediment Classification (% Sand)
Inner Harbor	Northwest Leg	60,900	2 to 3	ODMDS/Brandt Island	Bucket/Pipeline	23% to 77%
	West Leg	23,200	2 to 3	ODMDS/Brandt Island	Bucket/Pipeline	88% to 94%
	East Leg	57,200	2 to 3	ODMDS/Brandt Island	Bucket/Pipeline	40% to 95%
	Partial Range C	60,900	2 to 3	ODMDS/Brandt Island	Bucket/Pipeline	80% to 99%
Outer Harbor	Partial Range C	22,300	2 to 3	Beach/NSP*/ODMDS	Pipeline/Hopper	≥90%
	Range B	45,400	2	Beach/NSP*/ODMDS	Pipeline/Hopper	≥90%
	Cutoff	182,500	1	Beach/NSP*/ODMDS	Pipeline/Hopper	≥90%
	Range A out to Station 110+00	491,600	1	Beach/NSP*/ODMDS	Pipeline/Hopper	≥90%
Outer Entrance Channel	Range A, beyond Sta. 110+00	56,000	1 to 3	ODMDS	Hopper	47% to 99%
	Total	**1,000,000**				

ODMDS: Ocean Dredged Material Disposal Site   NSP: Nearshore Placement Area (*During adverse weather conditions, the contractor was given the option of placing material in the ODMDS)   Beach: Fort Macon State Park/Atlantic Beach

Table 2-1a. Summary of Dredging and Disposal Practices for Morehead City Harbor (1997-2008).

Year	IOP Year	IOP Plan followed	Scheduled Maintenance	Actual Maintenance	Scheduled disposal location	Actual disposal location	Cubic yards dredged	Awardable Bids?	Notes
2009	1	Year 1	Range A Cutoff	Inner Harbor	Beaches of Ft. Macon and Atlantic Beach	ODMDS	600,000	Yes	No awardable bids received for Ocean Bar Contract; McFarland (govt dredge) did minimal necessary dredging.
2010	2	Year 1	Range A Range B Cutoff	Range A Range B Cutoff	Beaches of Ft. Macon and Atlantic Beach	Beaches of Ft. Macon and Atlantic Beach	1,400,000	Yes	SAW elected to re-attempt Year 1 maintenance due to lack of awardable bids in previous year
2011	3	Year 3	Inner Harbor	Inner Harbor	ODMDS	ODMDS	470,000	Yes	SAW followed the Year 3 plan due to the need to maintain the Inner Harbor
2012	1	Year 2	Range A Cutoff	Range A Cutoff	Nearshore	Nearshore	400,000	No	No awardable bids received;McFarland did minimal necessary dredging
2013	2	Year 2	Range A Range B Cutoff	Range A Cutoff	Nearshore	Nearshore	420,000	No	SAW elected to re-attempt Year 2 maintenance due to small quantity dredged the year before, and due to limited funding. No awardable bids received;McFarland did minimal necessary dredging
2013 (2nd job)	2	Year 2	Range A Range B Cutoff	Cutoff	Nearshore	Nearshore	575,000	Yes	Pipeline dredge mobilized to deal with critical shoaling off the tip of Shackleford Island. Scows were used for nearshore placement.
2014	3	Year 1	Inner Harbor	Range A Cutoff	Beaches of Ft. Macon and Atlantic Beach	Beaches of Ft. Macon and Atlantic Beach	790,000	Yes	Successful Year 1 maintenance event
2015	1	Year 2	Range A Cutoff	None	Nearshore		-	No	No awardable bids received
2015 (2nd job)	1	Year 2	Range A Cutoff	Range A Cutoff	Nearshore	Nearshore / Ft. Macon	855,000	Yes	Pipeline dredge mobilized to deal with critical shoaling off the tip of Shackleford Island. Scows were used for nearshore placement.
2016	2	Year 3	Range A	None	Nearshore	None	-	No	No awardable bids received for Nearshore Placement Area disposal
2016 (2nd job)	2	Year 3	Range A	Range A	Nearshore	ODMDS	665,000	Yes	ODMDS disposal authorized after lack of awardable bids to Nearshore.

Table 2-1b. Summary of Dredging and Disposal Practices for Morehead City Harbor (2009-2016)

As shown in the tables above, annual maintenance dredging is required in some ranges within the Morehead City Harbor project to provide unrestricted navigation for ocean-going vessels calling upon the Harbor. When the navigation channels are maintained to their authorized depth, vessels drafting up to 42 feet may regularly call on the port. Vessels that draft up to 44 feet may call on the port using the advantage of high tide. On average, shoaling rates are such that the Inner Harbor navigation channels require maintenance dredging every two to three years, while portions of the Outer Harbor and Outer Entrance Channel require maintenance dredging on an annual basis. Note: Dredging quantities shown above are annual quantities; and detailed documentation of dredging quantities, by range, did not begin until 1997.

Inner Harbor. Maintenance dredging in the Inner Harbor has historically been accomplished by hydraulic pipeline dredge with disposal/placement on either the diked disposal area at Brandt Island or the beaches of Fort Macon State Park and Atlantic Beach. The Brandt Island disposal area has been used since 1955, and from 1978 through 2005 the majority of Inner Harbor dredged material was temporarily disposed of in Brandt Island and periodically pumped onto the adjacent beaches of Fort Macon State Park and Atlantic Beach. This beach placement of material compensated for any potential shoreline impacts associated with changes in sediment transport attributable to the federal navigation project (USACE 2001). The most recent Brandt Island pumpout (2005) was problematic in that it included placement of an unacceptable amount of fine-grained material onto the beach. This occurrence, along with recent USACE geotechnical investigations, indicates that Brandt Island and portions of the Inner Harbor contain material unfit for beach placement. As a result, since 2005, only fine-grained dredged material has been disposed of in Brandt Island and, due to the lack of accessible coarse-grained material in Brandt Island, there are no plans for future pumpouts from Brandt Island to the beach. Since the 2005 disposal, the Wilmington District has performed extensive geotechnical sampling within the project's navigation channels to better define the characteristics of the shoaled material. A summary of this analysis is included in Table 2-1.

Outer Harbor and Outer Entrance Channel. The Outer Harbor and Outer Entrance Channel maintenance dredging have historically been accomplished by hopper or pipeline dredge on an annual basis. Dredged material from the Outer Harbor is typically placed in the approved nearshore placement area (Figure 1-4) or on the shoreline at Fort Macon State Park and Atlantic Beach. During inclement weather, when conditions render it unsafe to navigate in the nearshore area, material has also been disposed of in the United States Environmental Protection Agency (USEPA) designated Morehead City Ocean Dredged Material Disposal Site (ODMDS) within the area designated for coarse-grained material. The Outer Entrance Channel material, which is fine-grained, is disposed of in the ODMDS within the area designated for fine-grained material. For more information regarding management of the ODMDS, see Section 3.2.3 (Ocean Dredged Material Disposal Site (ODMDS)).

Current Management of Morehead City Harbor Navigation Channels (Interim Operations Plan). Until the DMMP is finalized, Morehead City Harbor will be maintained in accordance with the IOP. The IOP was structured so that Morehead City Harbor maintenance dredging would occur on a three-year dredging rotation. The IOP was developed using past dredging quantities, recent geotechnical data, and current channel and disposal area conditions. The following paragraphs provide a detailed description of the dredging operations utilized for the three-year maintenance dredging cycle. Please note that all quantities provided below are estimates based upon historic shoaling and dredging quantities. Actual quantities vary. The operations detailed below are designed to occur within applicable environmental dredging and disposal windows.

Every reasonable effort is made to accomplish maintenance of the Morehead City Harbor project within the established windows. Anytime circumstances require that work be accomplished outside of the environmental windows, the USACE coordinates the action with all appropriate resource agencies prior to start of work.

The sediment sampling efforts the District conducted from 2003-08 identified that the majority of Inner Harbor material consists of fine-grained material which ranges from 23% to 99% sand with the majority of material being less than 90% sand. As a general rule, placement of dredged material on beaches is limited to that material which is at least 90% sand. Inner Harbor material is less than 90% sand and therefore not suitable for placement onto adjacent shorelines. Sampling also showed that the majority of the shoaled material located in the Outer Harbor consists of coarse-grained material suitable for beach or nearshore placement; with the exception of material in the Outer Entrance Channel from station 110+00 seaward (Figure 1-4). A summary of these sampling efforts and the results are provided in Section 4.1 (Sediment and Sand Resources) and in Appendix B of this report.

The inability to offset project impacts through Brandt Island pumpouts led to the revised management strategy for the Morehead City Harbor project (IOP)(Appendix A). The Environmental Assessment and Finding of No Significant Impact (EA/FONSI) for the IOP was completed in June 2009; it addressed modifications to the existing Morehead City Harbor dredged material disposal practices for an interim period while the Morehead City Harbor DMMP was being developed. The Interim Operations Plan dredging cycle is explained below. Please note that the quantities indicated are not measured quantities, but those identified in the plan as necessary for full maintenance of the channel to authorized depths.

Interim Operations Plan Year-1: Approximately 1.1 million cubic yards of coarse-grained material would be removed from the Morehead City Harbor Outer Harbor by pipeline dredge, and placed along the shorelines of Fort Macon State Park and Atlantic Beach.

Interim Operations Plan Year-2: Approximately 700,000 cubic yards of fine-grained material would be removed from the Morehead City Inner Harbor by hydraulic pipeline dredge with disposal in the Brandt Island confined disposal area, or by bucket and barge with disposal in the ODMDS. Approximately 250,000 cubic yards of coarse-grained material would be removed by hopper dredge from the Outer Harbor and placed within the existing nearshore placement area. Maintenance dredging in the Outer Harbor is anticipated to be minimal due to pipeline maintenance dredging performed in Year-1.

Interim Operations Plan Year-3: Approximately 750,000 cubic yards of coarse-grained material would be removed from the Morehead City Harbor Outer Harbor with a hopper dredge and placed within the existing nearshore placement area. Fine-grained material from the Outer Entrance Channel would be dredged with the same hopper dredge and disposed of within the ODMDS. Approximately 100,000 cubic yards of dredged material may also be removed by the same hopper dredge from portions of the Morehead City Harbor Inner Harbor and disposed of within the ODMDS.

Maintenance of Other Federal Channels in the Project Vicinity. Dredged material originating from Beaufort Harbor has a variety of material characteristics depending on location. This material has historically been disposed of in the following locations: Radio Island, Carrot Island, and the adjacent shoreline of Bogue Banks. These disposal areas will continue to be utilized for disposal of dredged material from Beaufort Harbor.

Dredged material originating from the southern Core Creek reaches of the Atlantic Intracoastal Waterway (AIWW) has historically been disposed of within the Radio Island disposal area. Radio Island will continue to be utilized for AIWW dredged material.

Dredged material originating from the Atlantic Beach Channels project has historically been disposed of within the Brandt Island upland disposal area. The dredging frequency for the Atlantic Beach Channels project is approximately once every 10 years, with an approximate quantity of only 30,000 cubic yards dredged each time.

Use of Disposal Sites by Other Government Entities. Maintenance dredging and disposal paid for by other government entities may periodically be included in USACE dredging contracts. Dredging that is the responsibility of another government agency and included in a USACE contract is typically addressed in an appropriate interagency agreement; these disposal volumes were considered in the development of the DMMP. These areas within the Morehead City Harbor DMMP study area include the non-federal berthing areas mentioned previously as well as the Fort Macon U.S. Coast Guard Station. About 15,000 cubic yards of material are removed annually from the non-federal berthing areas and approximately 70,000 cubic yards of fine-grained material are dredged every 6 years from the channels servicing the Coast Guard Station. Dredged material from these areas has historically been disposed of in Brandt Island, however, based on the results of sediment evaluations (pursuant to Section 103 of the Marine Protection Research and Sanctuaries Act (MPRSA)), material could go to the ODMDS and may do so during future dredging events. The small amount of material historically dredged from the non-federal berthing areas and the Coast Guard channels would have a negligible effect on the capacity of the ODMDS and therefore would not impact the long-term maintenance of the Morehead City Harbor navigation project.

Economic Conditions. Federal dredging projects in Morehead City Harbor began in 1910 with a 20' deep channel. Since then the Harbor has been studied and deepened four times to accommodate deeper draft vessels and changes in cargo. The last deepening project was completed in 1994 when the project was deepened to its currently authorized depths. The last in-depth economic analysis of the Port was completed in 1992 as part of the General Design Memorandum that recommended the currently authorized project. The project design was based on a 60,000 to 80,000 deadweight tons (DWT) bulk carrier drafting between 41 and 45 feet. Benefits were claimed for phosphate rock exports to Europe and the Indian

Subcontinent. Benefits were not claimed for exports to Australia or the Far East, because of draft limitations imposed by the Panama Canal. Historic tonnage from 1985-1991 (immediately preceding the deepening study) ranged from 3.6 to 6.3 million tons.

Although some changes have occurred in ship traffic and commerce, the Port is handling an average of 4.0 million tons of commerce annually since deepening was completed in 1994, which ranks it in the middle of U.S. deep-draft ports. It serves as a significant import and export port for a number of mining and manufacturing firms that are vital to the economy of North Carolina. In addition, it is Marine Corps Base Camp Lejeune's designated Seaport of Embarkation (SPOE) for military planning purposes. The Port also has two location characteristics that provide an advantage to commerce and maintenance costs. One of the major commodities shipped from the Port is phosphate converted to fertilizers. The phosphate mining operation is only 80 miles away, which is approximately 90 miles closer than the next nearest port located at Norfolk, Virginia. The Morehead City Port is also about 3 miles from the ocean, making it extremely accessible. Principal imports are sulfur products, rubber and scrap metal.

Most Recent Changes. The federal assumption of maintenance for the West Turning Basin was authorized in the Water Resources Development Act (WRDA) of 2000, subject to the Secretary of the Army's determination that the non-federal improvements were economically and environmentally justified. The USACE prepared a report and submitted it to the Assistant Secretary of the Army for Civil Works ASA(CW), who recommended federal assumption of maintenance of the West Turning Basin, which is located between the West and Northwest Legs. The West Turning Basin was originally constructed and maintained by the State of North Carolina. It is maintained at the same depth (35 feet) and dimensions as constructed. By letter dated September 20, 2002, the ASA(CW) approved federal assumption of maintenance of the Morehead City Harbor, West Turning Basin.

Since the General Design Memorandum was completed in 1992, Potash Corporation of Saskatchewan (PCS), a phosphate mining and manufacturing company with facilities in Aurora, NC, has changed from exporting mined phosphate rock to exporting processed fertilizers, mostly monoammonium phosphate (MAP) and diammonium phosphate (DAP). These are value-added products that are exported in deep draft vessels (usually drafting 36 to 42 feet). The exporting of phosphate rock was done in similar vessels, usually drafting from 38 to 45 feet. This change has allowed the maintenance dredging of the harbor to be somewhat flexible due to the fact that a limited amount of shoaling within the channel dimensions does not adversely impact Port traffic. Current dredging practices at the port reflect the draft requirements of recent ship traffic and Operations and Maintenance (O&M) funding limitations with maintenance not always being accomplished to the authorized project depth.

2.1.1 Waterborne Commerce

Waterborne commerce includes imports, exports and coastwise traffic in the Harbor. The Port has seen both growth and contraction in waterborne commerce from 1980 to 2011 (Table 2-2). Some of this is due to a fluctuation in phosphate and fertilizer movements, and some is due to the changing use of the port for various commodities. Morehead City Harbor has seen the arrival and departure of several major commodities, such as coal (arrived and later departed) and woodchips (arrived, departed, arrived), and steel (arrived). A breakdown of commerce by commodity is given below in Table 2-3. For the period from 2007 through 2011, a summary of vessel traffic by trips and drafts is provided in Table 2-4.

Calendar Year	Waterborne Commerce (Tons)	Calendar Year	Waterborne Commerce (Tons)
1980	3,066,000	1996	5,588,000
1981	3,890,000	1997	5,201,000
1982	3,724,000	1998	5,260,000
1983	4,233,000	1999	4,636,000
1984	4,190,000	2000	4,365,000
1985	3,626,000	2001	3,143,000
1986	5,225,000	2002	2,097,000
1987	5,584,000	2003	2,297,487
1988	6,287,000	2004	3,407,127
1989	6,159,000	2005	3,953,663
1990	5,049,000	2006	3,733,318
1991	5,237,000	2007	3,108,000
1992	4,440,000	2008	3,300,000
1993	3,999,000	2009	3,278,000
1994	4,195,000	2010	3,498,000
1995	4,620,000	2011	3,570,000

Table 2-2. Waterborne Commerce - 1980-2011

	All Traffic Types (Domestic & Foreign)														
	All Traffic Directions					Receipts					Shipments				
	CY2011	CY2010	CY2009	CY2008	CY2007	CY2011	CY2010	CY2009	CY2008	CY2007	CY2011	CY2010	CY2009	CY2008	CY2007
All Commodities	3,569,512	3,497,666	3,278,457	3,300,143	3,108,310	1,901,665	2,044,637	1,741,639	1,921,157	1,834,175	1,667,847	1,451,432	1,536,818	1,378,986	1,274,135
Total Coal, Lignite and Coal Coke	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Petroleum and Petroleum Products	2,431	37,597	13,287	78,955	90,222	2,408	37,597	13,287	78,955	90,222	23	0	0	0	0
Total Chemicals and Related Products	3,111,344	2,944,146	2,908,578	2,610,342	2,221,398	1,591,816	1,596,268	1,432,233	1,375,385	997,578	1,519,528	1,346,281	1,476,345	1,234,957	1,223,820
Subtotal Fertilizers	1,136,024	1,012,934	1,258,353	1,003,525	1,061,980	613,702	629,985	611,348	603,002	523,554	522,322	381,352	647,005	400,523	538,426
Subtotal Other Chemicals and Related Products	1,975,320	1,931,212	1,650,225	1,606,817	1,159,418	978,114	966,283	820,885	772,383	474,024	997,206	964,929	829,340	834,434	685,394
Total Crude Materials, Inedible Except Fuels	202,524	298,006	229,877	399,011	557,247	175,066	250,343	202,765	309,705	534,753	27,458	47,663	27,112	89,306	22,494
Subtotal Forest Products, Wood and Chips	139,199	139,222	65,491	155,625	179,794	139,199	137,251	65,491	151,822	176,008	0	1,971	0	3,803	3,786
Subtotal Pulp and Waste Paper	793	0	0	540	14,108	0	0	0	540	0	793	0	0	0	14,108
Subtotal Soil, Sand, Gravel, Rock and Stone	59	0	47,920	96,300	93,018	18	0	47,920	96,300	93,018	41	0	0	0	0
Subtotal Iron Ore and Scrap	28,575	54,668	74,323	128,084	21,794	2,211	8,976	47,211	42,581	17,194	26,364	45,692	27,112	85,503	4,600
Subtotal Marine Shells	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal Non-Ferrous Ores and Scrap	58	0	0	0	17,417	20	0	0	0	17,417	38	0	0	0	0
Subtotal Sulphur, Clay and Salt	21,547	0	42,143	18,462	221,981	21,347	0	42,143	18,462	221,981	200	0	0	0	0
Subtotal Other Non-Metal. Min.	12,293	65,116	0	0	9,135	12,271	65,116	0	0	9,135	22	0	0	0	0
Total Primary Manufactured Goods	121,299	140,807	80,154	162,530	156,244	65,335	130,277	48,062	107,807	129,205	55,964	10,530	32,092	54,723	27,039
Subtotal Paper Products	934	0	0	138	1,691	334	0	0	138	302	600	0	0	0	1,389
Subtotal Lime, Cement and Glass	395	0	0	0	359	102	0	0	0	359	293	0	0	0	0
Subtotal Primary Iron and Steel Products	115,859	112,837	55,295	134,123	112,773	61,235	102,307	23,203	79,400	90,123	54,624	10,530	32,092	54,723	22,650
Subtotal Primary Non-Ferrous Metal Products	3,851	13,814	11,278	9,973	14,473	3,664	13,814	11,278	9,973	11,473	187	0	0	0	3,000
Subtotal Primary Wood Products; Veneer	260	14,156	13,581	18,296	26,948	0	14,156	13,581	18,296	26,948	260	0	0	0	0
Total Food and Farm Products	25,900	0	171	32,509	43,759	25,856	0	103	32,509	43,759	44	0	68	0	0
Subtotal Oilseeds	19	0	0	0	0	19	0	0	0	0	0	0	0	0	0
Subtotal Vegetable Products	122	0	0	0	0	100	0	0	0	0	22	0	0	0	0
Subtotal Processed Grain and Animal Feed	57	0	44	0	0	55	0	0	0	0	2	0	44	0	0
Subtotal Other Agricultural Products	25,702	0	127	32,509	43,759	25,682	0	103	32,509	43,759	20	0	24	0	0
Total All Manufactured Equipment, Machinery	104,616	74,673	21,795	16,558	34,273	41,020	27,715	20,594	16,558	33,573	63,596	46,958	1,201	0	700
Total Unknown or Not Elsewhere Classified	1,398	2,437	24,595	238	5,167	164	2,437	24,595	238	5,085	1,234	0	0	0	82

Table 2-3. Commerce Based on Commodity

	All Vessel Types														
	All Traffic Directions	Receipt	Shipment		Receipt	Shipment		Receipt	Shipment		Receipt	Shipment		Receipt	Shipment
	CY2011			CY2010			CY2009			CY2008			CY2007		
All Drafts	2,402	1,197	1,205	2,505	1,255	1,250	2,215	1,107	1,108	2,789	1,400	1,389	2,074	1,039	1,035
0-5 ft.	608	75	533	657	94	563	575	145	430	1,086	431	655	529	162	367
6-9 ft.	1,247	686	561	1,283	715	568	1,225	649	576	1,305	681	624	1,143	592	551
10-12 ft.	327	324	3	318	315	3	217	214	3	173	169	4	168	166	2
13-14 ft.	1	1	0	25	24	1	7	6	1	12	8	4	2	2	0
15-17 ft.	7	5	2	10	3	7	7	5	2	8	6	2	13	8	5
18-20 ft.	26	14	12	30	14	16	39	12	27	34	16	18	32	10	22
21-23 ft.	31	21	10	21	14	7	27	16	11	26	12	14	40	21	19
24-26 ft.	36	18	18	47	20	27	31	18	13	28	19	9	30	15	15
27-29 ft.	33	15	18	31	20	11	34	19	15	52	22	30	42	22	20
30-32 ft.	35	21	14	38	23	15	25	20	5	29	22	7	32	23	9
33-35 ft.	19	12	7	20	7	13	14	2	12	21	10	11	30	16	14
36-38 ft.	23	4	19	20	6	14	11	1	10	12	4	8	8	1	7
39-40 ft.	9	1	8	5	0	5	1	0	1	2	0	2	3	0	3
41 ft.	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
42 ft.	0	0	0	0	0	0	1	0	1	1	0	1	1	1	0
43 ft.	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
44 ft.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45 ft.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 2-4. Vessel Traffic by Trips and Drafts (data from the Waterborne Commerce Statistics Center)

North Carolina State Ports Authority. The NCSPA operates the State Port at Morehead City. This terminal has several attractive characteristics to serve both commercial and military cargo. It is only 3 miles from the open sea; its channel is 3 feet deeper than the larger port at Wilmington; and Morehead City's proximity to the ocean and nearby military facilities has supported a strong military presence. Cargo handling activities at Morehead City Harbor support nearly 4,000 jobs statewide and generate $26 million annually in local and state tax revenues.

Morehead City handles mostly bulk cargo with some break-bulk and general cargo. Bulk Cargo is loose cargo (dry or liquid) that is loaded (shoveled, scooped, forked, mechanically conveyed or pumped) in volume directly into a ship's hold; e.g., grain, coal and oil. Break-bulk cargo is non-containerized general cargo stored in boxes, bales, pallets or other units to be loaded onto or discharged from ships or other forms of transportation. Examples include iron, steel, machinery, linerboard and wood pulp. The Port is second only to New Orleans, Louisiana, in rubber imports. Other key imports are sulfur products, ore and stone, scrap metal, and aggregate. The port exports primarily one thing — phosphate fertilizers. In 2009, the NCSPA Port at Morehead City processed more than 3.3 million tons of cargo, with much of that moving to and from India, Venezuela, Brazil, China, and Indonesia. Table 2-6 provides detailed information about NCSPA commodities being imported and exported from 2002 to 2011. Table 2-7 provides information about the top ten trading partners for Morehead City. The Pacific Rim nations send their cargo to East Coast ports for two reasons, says Karen Fox, director of communications at NCSPA. First, booming international trade is congesting West Coast ports. Second, Fox says, "It's still more cost effective to take your ship through the Panama Canal and by water to east coast ports than it is to go to a west coast port and rail the cargo across the country."

The Morehead City Harbor serves as a gateway to world markets for North Carolina business and industry. Products handled include phosphate fertilizers exported by PCS Phosphate of Aurora, lumber for construction and retail sale, natural rubber used for tire manufacturing at the Bridgestone Firestone plant in Wilson and the Goodyear plant in Fayetteville, scrap metal for the Nucor Steel plant in Hertford County, colemanite used in fiberglass, and military equipment to support our national defense efforts.

Morehead City has facilities to serve the needs of deep draft vessels. Berths, cargo handling equipment and warehouse space are available at the NCSPA docks. As a leading exporter of phosphate, the port features a dry-bulk facility with a 225,000-ton capacity warehouse and open dry-bulk storage. The Port opened a new 177,000 square foot storage warehouse in 2007 to enhance its facilities. It is designed to house high value commodities such as paper, steel, and lumber. This warehouse features 29' ceilings and easy access to ocean berths.

Commercial tug power consists of 4 tugs ranging in size from 350 to 1400 horsepower. The nearest facilities for major repairs to military and commercial vessels are at Norfolk and Newport News, VA.

Commerce for the NCSPA docks from 2002-2011 is shown below in Table 2-5 and Figure 2-1. The State of North Carolina is on a data year of July 1 to June 30, so data will not match up with information from the Navigation Data Center. The data below does not include commerce at other terminals in the Harbor, or military use. The Waterborne Commerce Data includes all commerce in the Harbor, except military. Military commerce on military owned or chartered ships is not required to report to Waterborne Commerce.

10-Year Vessel Trend			Ten Year Tonnage Trend			
Fiscal Year	Ships	Barges	Year	Breakbulk	Bulk	Total
2011	128	549	2011	212,182	1,798,379	2,010,561
2010	122	465	2010	198,965	1,569,747	1,768,712
2009	118	415	2009	167,454	1,725,432	1,892,886
2008	124	414	2008	231,072	1,652,863	1,883,935
2007	153	436	2007	276,128	1,862,213	2,138,441
2006	164	411	2006	375,998	1,922,386	2,298,384
2005	156	348	2005	315,440	2,115,309	2,430,749
2004	168	250	2004	214,948	2,000,643	2,215,591
2003	153	191	2003	243,574	1,296,618	1,540,692
2002	132	209	2002	213,583	1,294,005	1,507,588

Table 2-5. NCSPA 10-Year Vessel and Tonnage

Note: The latest available Waterborne Commerce data is from 2011.

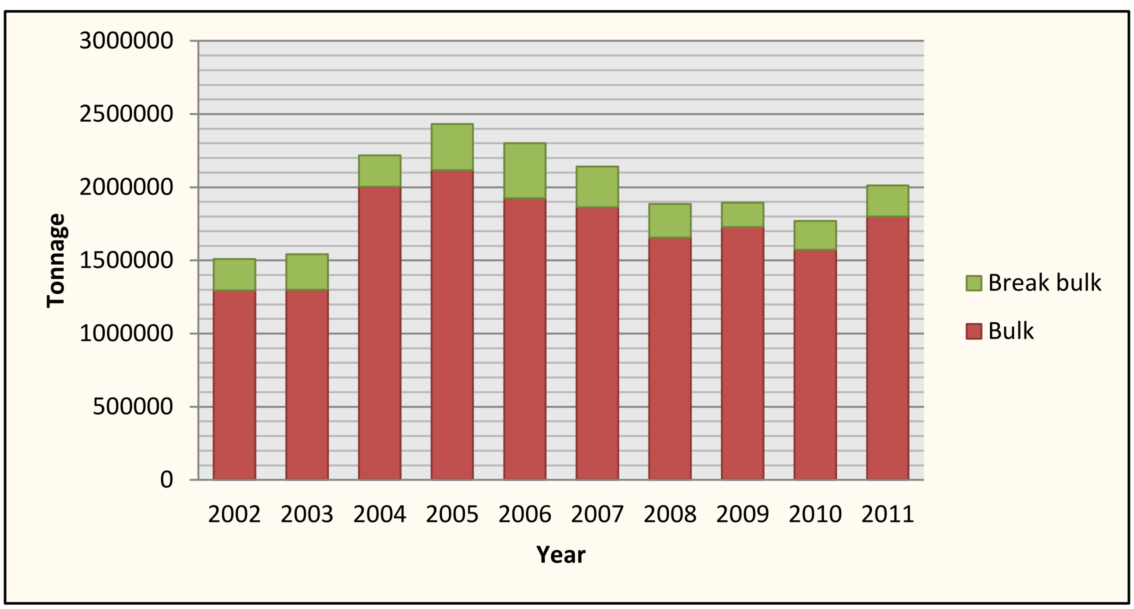


Figure 2-1. NCSPA 10-Year Vessel and Tonnage

Year	Commodity	Import	Commodity	Export
2011	Sulfur Products	165,597	Phosphate	1,397,717
	Rubber	132,914	Metal Products	19,119
	Scrap Metal	99,851	Scrap Metal	8,969
	Potash	56,622	Military	4,165
	Metal Products	46,973	Urea	1,504
2010	Sulfur Products	298,706	Phosphate	1,090,649
	Rubber	119,358	Gen. Merch./Misc	47,091
	Scrap Metal	83,525	Military	2,748
	Metal Products	57,811		
	Ore, Micah, Schist	26,268		
2009	Sulfur Products	326,147	Phosphate	1,044,249
	Rubber	117,505	Military	2,981
	Gen Merch/Misc	108,617		
	Scrap Metal	76,709		
	Ore, Mica, Schist	56,107		
2008	Sulfur Products	286,768	Phosphate	1,044,249
	Rubber	155,163	Military	1,510
	Scrap Metal	126,901		
	Aggregate	94,532		
	Ore, Mica, Schist	59,635		
2007	Sulfur Products	283,018	Phosphate	1,211,017
	Rubber	157,849	Forest Products	3,787
	Ore, Mica, Schist	114,639	Military	3,500
	Scrap Metal	111,001	Gen. Merch./Misc	1,317
	Aggregate	91,067		
2006	Scrap Metal	363,125	Phosphate	1,041,117
	Sulfur Products	295,439	Military	6,199
	Rubber	251,874	Gen. Merch./Misc	1,271
	Ore, Mica, Schist	136,489		
	Forest Products	78,810		
2005	Sulfur Products	457,539	Phosphate	1,121,970
	Scrap Metal	285,550	Aggregate	8,641
	Rubber	206,614	Metal Products	8,337
	Asphalt	115,537	Military	8,125
	Ore, Mica, Schist	110,051	Gen. Merch./Misc	2,995
2004				
	Scrap Metal	303,540	Military	10,557
	Rubber	175,765	Metal Products	4,750
	Asphalt	152,756	Gen. Merch./Misc	2,006
	Ore, Mica, Schist	90,545		
2003	Sulfur Products	299,780	Phosphate	666,640
	Rubber	180,201	Metal Products	27,095
	Ore, Mica, Schist	114,960	Military	14,590
	Asphalt	93,506	Gen. Merch./Misc	4,263
	Scrap Metal	85,154	Food	2,198
2002	Sulfur Products	212,004	Phosphate	444,660
	Scrap Metal	179,307	Woodchips	163,815
	Rubber	149,024	Military	13,659
	Ore, Mica, Schist	133,277	Gen. Merch./Misc	2,656

Table 2-6. NCSPA Top Five Commodities by Year- 2002-2011

Import		Export		Total Trade	
Indonesia	106,732	India	1,063,415	India	1,063,572
Mexico	92,525	Brazil	256,695	Brazil	308,906
Venezuela	59,216	Argentina	28,611	Indonesia	106,732
Brazil	52,211	Colombia	26,935	Mexico	92,525
Turkey	39,325	Peru	16,388	Venezuela	63,625
Israel	35,477	Honduras	7968	Turkey	39,325
Poland	34,289	Venezuela	4409	Israel	35,477
Russia	33,270	Puerto Rico	4210	Poland	34,289
Thailand	27,316	Chile	3453	Russia	33,270
Canada	26,010	Dom. Republic	2022	Argentina	28,611

Table 2-7. Top Ten Trading Partners, Morehead City, 2011

Military Use. Next to California and Texas, North Carolina has the third-largest number of active duty military personnel in the U.S., with over 100,000 soldiers and an additional 46,000 civilian, reserve, and National Guard personnel. North Carolina is home to: Marine Corps Base Camp Lejeune; Marine Corps Air Station New River; Marine Corps Air Station Cherry Point; Fort Bragg, United States Army Installation; Pope Army Airfield; Military Ocean Terminal Sunny Point; Seymour Johnson Air Force Base; and Air Station Elizabeth City, United States Coast Guard. Morehead City Harbor is the main port of embarkation and debarkation for the Second Division of the U.S. Marine Corps at Camp Lejeune.

The U.S. Navy-owned facilities in the Morehead City/Beaufort area include three Landing Ship, Tank (LST) ramps and a large paved staging area at the southern tip of Radio Island. The Navy also uses portions of the NCSPA facility, mainly the area adjacent to the West and Northwest legs. The West leg also includes an LST ramp. Commercial traffic includes deep draft vessels (general, break-bulk and bulk cargo), AIWW traffic and the commercial fishing fleets. Deep-draft vessels berth at the State Port, Morehead City and a liquid bulk terminal on Radio Island. These vessels also may transport some military cargo for the nearby military bases and facilities.

Navy use of the Harbor centers on the embarking and debarking of Marine Corps elements based at Camp Lejeune and Cherry Point. The Navy-owned LST ramps at Radio Island are for this purpose. Additionally, by prior arrangement through the Naval Port Control Office with the management of the State Port, visiting Navy ships may also use deep water berths or the state-owned LST ramps at the port. The latter are rarely used due to awkward approaches for vehicles. Eight deep water berths are used for loading Navy amphibious ships. Vessels operated by or chartered to the Military Sealift Command berth at the Aviation Fuel Terminal on Radio Island. Both the Navy and the Military Sealift Command ships use the Port of Morehead City for their activities.

Value of Commodities. In the most recent data available from 2011, Morehead City Harbor (including Beaufort) reported commodities handled of $575 million worth of exports and $497 million worth of imports. These imports, along with coastwise shipments and receipts, are required to pay into the Harbor Maintenance Trust Fund

(HMTF), which is described below. Coastwise shipments are ocean commerce that goes from one U.S. port to another.

Channel Portfolio Tool. The Channel Portfolio Tool (CPT), previously known as the Channel Prioritization Tool, is a decision-support software package designed by ERDC to assist Corps Operations personnel with Operations and Maintenance (O&M) dredging budget development. CPT uses the Corps-use-only, dock-level tonnage database provided by IWR's Waterborne Commerce Statistics Center (WCSC) to provide Operations personnel with ready access to information concerning utilization of channel depths by commercial shipping. The underlying commerce data are the same figures that feed existing tools such as Operation and Maintenance Business Information Link (OMBIL), but CPT allows for these data to be more fully analyzed and viewed in more detail, as opposed to a single tonnage value for an entire navigation project. CPT is web-accessible and provides various levels of detail, from sub-reach level resolution all the way to Division-level consolidated statements of cargo. A commodity flow feature allows the user to see all other US ports, channels, and waterways used by cargo transiting a given reach. CPT has been developed in direct response to calls from USACE-HQ for more consistent, transparent, and objective prioritization of O&M dredging budget items, and preliminary briefings to OMB examiners have been received favorably. Wilmington District’s use of CPT represents early adoption of an approach expected to be employed throughout USACE. Representatives from the Deep Draft Navigation PCX have been briefed on CPT on at least one occasion during a visit to ERDC. However, since CPT has been conceived as a tool primarily for assisting Operations personnel with year-to-year O&M budgeting, Deep Draft Navigation Planning Center of Expertise has not yet been consulted extensively. Though still in the developmental stages, it is anticipated that CPT may ultimately have applications beyond O&M budgeting, so ERDC developers welcome collaboration with other potential Corps user groups. The CPT is not a planning model; it is a tool for quickly accessing the existing Waterborne Commerce data to inform O&M budgeting.

Therefore, the requirement for model certification would not apply. ERDC is still validating it against the official, published WCSC figures, hence labeling it as "developmental". The CPT is not used in any sort of "planning" capacity within the DMMP, but is used only to present existing data on the port of Morehead City to indicate its importance to the Nation.

This tool is still preliminary, but information on Morehead City Harbor is now being processed. The following table shows the average flow of tons and value at various drafts for 2003-2010. For this time series, the data showed Morehead City Harbor handle, on average, about 2.9 million tons of cargo having a value of almost $920 million.

	Draft (feet)	Tonnage (x1k)	Value (x1k)
Commodity traffic	44	7.5	$944
	43	8.4	$2,503
	42	41.6	$14,324
	41	8.6	$2,933
	40	52.6	$22,785
	39	25.5	$4,753
	38	69.4	$18,590
	37	67.2	$19,492
	36	124.7	$60,354
	35	149.7	$55,370
	34	119.8	$50,003
	33	58	$95,126
All Commodity traffic drafting 32 feet or less		2,248	$572,280
Total Traffic for Morehead City Harbor		2,981	$919,457

Table 2-8. Tonnage and Value of Commodities by Vessel Draft

Table 2-8 shows that there are about 119 tons worth about $43,500,000 in the last 5 feet of draft (40 to 44 feet). This tool will allow Morehead City Harbor to be compared to other similar sized harbors, to see the tons and value being handled at various depths. We do not know yet how the Morehead City Harbor will stack up against these other ports, or how the designation of a strategic military harbor will impact the budget process. This tool is another indicator for developing the annual operation and maintenance budget for deep-draft harbors.

Panama Canal Expansion. The existing Panama Canal dimensions can accommodate a maximum vessel draft of 39.5 feet (tropical fresh water), maximum vessel beam of 106 feet, and maximum vessel length of 965 feet. Presently, vessels calling at Morehead City Harbor are limited to about 38.5 feet salt water draft if their itinerary includes going through the existing Panama Canal. The expanded canal, which is currently scheduled for completion in mid-2016, is designed to accommodate a maximum vessel draft of 50 feet (tropical fresh water), maximum vessel beam of 160 feet, and maximum vessel length of 1,200 feet. Possible effects of the Panama Canal Expansion may be a shift of vessels arriving from Asia or carrying exports to Asia to larger or deeper draft vessels. As this restraint at the Panama Canal is lifted, larger vessels may be able to use the additional draft at Morehead City. In other words, trade with Morehead City would no longer be draft-limited by the Canal once the planned expansion occurs. This would open markets in the Far East, Southeast Asia, Australia, and the West Coast of South America to deeper-draft trade with Morehead City.

As currently maintained, the Morehead City Harbor could accommodate vessels coming through the expanded canal to a depth of about 42 feet under normal conditions and up to 44 feet using the advantage of high tide.

Future Port Facilities Expansion. The North Carolina State Ports Authority owns about 250 acres on Radio Island, of which 150 acres is suitable for additional port development. An Environmental Impact Statement (EIS) on the property, prepared in 2001, calls for construction of a marine terminal with 2,000 feet of wharf, warehouse space, and paved open storage. The EIS also specifies dredging to bring the 45-foot-deep Morehead City navigational channel to the face of Radio Island. These proposed facilities can be expected to increase shipping and commerce in the Harbor, if and when the development is undertaken.

2.1.2 Economic Viability

Morehead City Harbor serves as a significant import and export harbor for a number of mining and manufacturing firms that are vital to the economy of North Carolina. In addition, given Morehead City Harbor's short entrance channel and its proximity to important military bases, it is also a strategic, fast-strike military port capable of launching forces, equipment and munitions. Military bases are important to the economic and employment base for North Carolina, and the two deep draft ports of Wilmington and Morehead City are strategic ports for the U.S. military. Continuing development of the Global TransPark (GTP) in Kinston will increase commerce coming through the port of Morehead City. The State is building a rail spur to a Spirit Aero Systems facility in the GTP to allow rail connection to the Morehead City Harbor. Airplane sections built in Kinston will be exported to Europe through the Port. This rail spur is expected to serve additional industries as the park continues to develop. As the recession eases and bulk shipping continues to recover, additional commerce can be expected to use the Morehead City Harbor.

One of the requirements of a DMMP is to demonstrate that continued maintenance is economically warranted based on high priority (non-recreation) benefits. The above information shows the economic importance of Morehead City Harbor to the Nation, the Region, the State and the Military. Morehead City Harbor delivers high priority National Economic Development (NED) benefits, is a National Strategic Port and, therefore, warrants at least 20 more years of continued O&M dredging.

2.1.3 Existing Physical Conditions

Morehead City Harbor contains one of the most accessible deep-draft ports on the east coast of the United States. The Port is located only three miles from the open sea and the channel is easily navigable.

As a leading exporter of phosphate, the Port features a dry-bulk facility with a 225,000-ton capacity warehouse and open dry-bulk storage. Access to Interstates 95 and 40 is available via U.S. Highways 70 and 17 in addition to daily train service from Norfolk Southern.

The Port has two 115-ton capacity gantry cranes, a container crane, 36 lift trucks, a certified truck scale, and a constant motion rail scale. In 2007, the Port opened a new 177,000 square foot storage warehouse, which is available to house high value commodities such as paper, steel, and lumber. The State Ports Authority also owns approximately 150 acres of undeveloped acreage adjacent to the Morehead City navigation channel on Radio Island.

Full-service port support is available onsite, including stevedores, agents, line handlers, towing companies, chandlers, brokers, bankers, and marine repair facilities. All U.S. Customs services are provided at the Port of Morehead City.

The Port is approved as Foreign Trade Zone 67. A Foreign Trade Zone allows for storage, manipulation, exhibition, and limited manufacturing operation for cargo. The Foreign Trade Zone can lower, defer or avoid import duties.

Morehead City Harbor is located within the confluence of the Newport River and Bogue Sound. The average tidal range from mean high water to mean low water in Morehead City Harbor is about 3.1 feet.

Salinity concentrations in the navigation channel through Beaufort Inlet are near sea strength (Salinity greater than 34 parts per thousand) and range from 29.0 parts per thousand (ppt) to 34.5 ppt depending on the sample location, tidal cycle and freshwater discharge (Churchill et al. 1999).

2.2 Planning Requirement

The DMMP alternatives were developed in accordance with federal policy guidance included in the Planning Guidance Notebook (Appendix E of ER 1105-2-100) regarding the planning process and methods of analysis. The USACE planning process is grounded in the economic and environmental Principles and Guidelines (P&G). The P&G were set forth to provide for the formulation of reasonable plans responsive to National, State and local concerns. The USACE planning process places specific emphasis on sound judgment, and planners and other team members shall be guided by common sense in applying the USACE planning process, which consists of the following six steps:

Step 1 - Identifying problems and opportunities
Step 2 - Inventorying and forecasting conditions
Step 3 - Formulating alternative plans
Step 4 - Evaluating alternative plans
Step 5 - Comparing alternative plans
Step 6 - Selecting a plan

2.3 Problems and Opportunities

Identification of problems and opportunities is the first step of the USACE planning process defined by the Planning Guidance Notebook (ER 1105-2-100). This step is very important to the overall process and is conducted in each phase of DMMP studies. At the beginning of this final DMMP phase, the PDT discussed the issues and concerns involving all aspects of project O&M and identified dredging and disposal needs for each range of the Morehead City Harbor project. Environmental concerns and issues were further identified, defined, and discussed during the initial planning efforts for the DMMP study. Federal and State resource agency concerns, views, and input were received during the National Environmental Policy Act (NEPA) scoping process and during informal discussions at monthly Project Delivery Team (PDT) meetings. The principal problems and potential opportunities are briefly addressed below. More specific discussion of problems and opportunities is included in Section 3 (Alternatives) of this document.

<u>Problems</u>.

- The USACE annually removes over one million cubic yards of material from the Harbor and currently there is no formal plan in place that ensures that sufficient disposal capacity is available for at least the next 20 years. Current maintenance disposal practices, without modification, will result in the need for new or expanded disposal sites, or modified disposal options, by 2028.

- As discussed in detail in Section 3 (Alternatives), data suggests that there has been substantial deflation of the ebb tide delta at Beaufort Inlet.

- Beach placement areas provide essentially unlimited disposal capacity, but the use of beaches for dredged material disposal is constrained by sediment quality, environmental windows, and costs.

- Shoaling and urgent dredging needs may occur at times when dredging and disposal options, such as beach placement, would conflict with acceptable environmental windows.

- <u>Opportunities</u>:

- There are opportunities for the beneficial use of dredged material for environmental purposes, including fish and wildlife habitat creation, ecosystem restoration and enhancement, and/or coastal storm damage reduction.

- Placement of suitable maintenance dredged material in nearshore placement areas along the ebb tide delta would retain sediment in the littoral system and reduce future deflation of the ebb tide delta.

- Use of upland disposal sites can aid in the creation and preservation of habitats for various species of plants and animals.

- There is opportunity for implementation of a regional sediment management (RSM) approach for dredged sediments, where dredged material is disposed of based on beneficial and economic considerations.

Environmental stewardship is a continual goal of the USACE. The USACE is continually challenged to determine how to conduct work in a more cost efficient manner without adversely impacting the environment. Therefore, this Dredged Material Management Plan is being developed as the most flexible, engineeringly sound, economically justified plan that can be reasonably implemented, performed in an environmentally acceptable manner. Pursuant to 33 CFR 335.4, the USACE undertakes operations and maintenance activities where appropriate and environmentally acceptable. All practicable and reasonable measures are fully considered on an equal basis. This includes the discharge of dredged material into waters of the U.S. or ocean waters in the least costly manner, at the least costly and most practicable location, and consistent with engineering and environmental requirements.

2.4 Key Assumptions

General. The key assumptions made for this study are that the base physical and economic conditions will continue throughout the 20-year period of analysis, beginning in 2016 and going through 2035.

The DMMP assumes that the Morehead City Harbor navigation project will be maintained to the fully-authorized project dimensions. It is assumed that the North Carolina State Port in Morehead City will remain viable and that maintenance of the Harbor will continue at least through the next 20 years It is also assumed that there will continue to be a demand for recreational and commercial boating and fishing throughout the study area.

Additionally, physical surveys used throughout the report are assumed to have been through sufficient quality control procedures when acquired to eliminate systematic survey errors. As such, any errors associated with present and past surveys are considered random. These random errors are considered equally distributed and are not considered in any calculations. One exception to this is the June 2005 ebb tide delta survey which was found to have an error associated with the data file. Due to the limited quantity of ebb tide delta surveys available for use in this report, this survey was adjusted and used in the delta deflation calculations. A detailed description of the corrective measures applied to this particular survey is included in Section 3.2.4.1 of this report.

Throughout this document, the terms "placement" and "disposal" will be used to describe the deposition of dredged material in various locations. These terms have occasionally been used interchangeably, and for clarity, the Wilmington District would like to explain what these terms mean, and what they do not. The term "disposal" has traditionally been used in USACE documents to describe the deposition of dredged material from navigation channels, whether that material is deposited in an upland diked disposal area, an offshore disposal area, a nearshore area, or a beach. Recently, USACE has continued to use the term "disposal" for deposition of material in upland diked disposal areas and offshore sites, but has begun to use the term "placement" for deposition of that material, particularly sandy material, in a nearshore area or on a beach. This change of term does not indicate that USACE has changed the meaning of the policies underlying the deposition itself. Rather, the term "placement" is intended to acknowledge that sand is a valuable resource to inlet and littoral systems, and therefore the common usage of the term "disposal", which means to throw something away, is not applicable to these situations. Therefore, throughout this document, the term "placement" will be used when describing deposition of sandy material in nearshore or beach locations.

It is important, however, to understand what "placement" means and does not mean. "Placement" of dredged navigation material continues to mean deposition of that material in accordance with the Federal standard: utilizing the least costly alternatives consistent with sound engineering practices and meeting the environmental standards established by the Clean Water Act Section 404(b)(1) evaluation process or ocean dumping criteria. It does not mean that beach or nearshore material placement is designed specifically to protect a beach, is specific mitigation for project-related effects, or relies upon identified storm reduction or environmental benefits to justify quantities or locations of placement. It also does not mean that beach or nearshore placement sites will be designed to meet a specifically-designed template, or to prioritize the sand "needs" of a specific section of beach over navigation project priorities. It is the goal of USACE to make dredged navigation material available to meet many of these other important priorities, and to design its projects to minimize the effects of its maintenance dredging on adjacent shorelines and inlet complexes. To the extent that the Wilmington District is able to beneficially use dredged material to accomplish other useful purposes while still maintaining its obligation to meet the Federal standard for dredged material deposition, it will continue to do so.

Sediment analyses. In an attempt to retain more maintenance dredged material in the Beaufort Inlet system and to prolong the longevity of Brandt Island, an additional analysis of sediment samples was conducted in 2011 to further discern the various sediment types within the Harbor. As shown in Figure 2-2, the Harbor ranges have now been divided into three categories: (1) fine-grained material less than 80% sand; (2) material between 80% and 90% sand; and (3) material greater than or equal to 90% sand. The Northwest Leg, a portion of the West Leg (referred as West Leg 1) and the East Leg contain fine-grained sediments less than 80% sand. The eastern portion of the West Leg (West Leg 2) and North Range C contain sediments that are between 80% and 90% sand. From South Range C out to station 110+00 of Range A, sediments are greater than or equal to 90% sand. The area in Range A between stations 117+00 and 100+00 contains sediments that are between 80 and 90% sand and the very outer end of Range A beyond station 117+00 contains fine-grained sediments less than 80% sand. The base plan for the DMMP is based on these sediment characteristics.

Figure 2-2. Inner/Outer Harbor Dredged Material Separation Based on Percent Sand

Shoaling Rates. One of the most important technical assumptions made during development of the DMMP is the use of annual shoaling rates as the basis for dredged material volumes, costs and required disposal capacity. Appendix C contains a detailed explanation of how the shoaling rates were calculated. As explained in Appendix C, the purpose of the shoaling analysis is to determine the average amount of material that is shoaling into the navigation channel at Morehead City Harbor on an annual basis. Shoaling rate estimates provide the most conservative approach in determining future disposal capacity requirements because they include all material coming into the system. In general, the shoaling rate numbers represent the greatest material volumes that would ever be expected to be dredged from the Morehead City Harbor Navigation Channel (assuming no funding limitations). All DMMP analyses, including sediment volumes and costs, are based on maintaining the Morehead City Harbor channel to its fully authorized dimensions.

Comparison of the past dredging records to the calculated shoaling rates show that the amount of material typically dredged is less than the computed annual shoaling rates for the channel. Past dredging quantities are constrained by several factors which result in these volumes being less than the computed average annual shoaling rate. Some of the factors that impact the past dredging quantities and explain the separation between the two numbers include:

1) During the actual dredging operation the contractor assumes responsibility for the occupied channel and any shoaling that occurs during the dredging operation. Depending on the channel conditions, a contractor may occupy a channel for up to 10 weeks while dredging the channel to a contract template. A significant percentage of the annual shoaling is essentially removed at no direct cost to the Government during this contractor-occupied period.

2) As discussed in Appendix C, the shoaling rate is an annual quantity developed through averaging changes within the channel over time. Throughout the channel, past dredging practices have been limited by funding and as a result, the areas that restricted the channel the greatest were dredged. The quantities removed during these events do not represent removal of all shoaling within the channel or even all shoaling that may impede shipping. They are simply the quantity removed with the funding available for that dredging event. This funding-limited dredging approach results in the actual dredged quantity being lower than the shoaled quantity for a given reach and partially explains the difference between the computed shoaling rate and past dredged quantities.

3) The third factor which may explain why computed shoaling rates exceed past dredging quantities is that the shoaling rates were developed by comparing surveys between dredging events and not by comparing surveys to a project template. Past dredging quantities would not include material removed below a project template as this material is defined in the contract as “non-pay”. “Non-pay” material is material that has been dredged from an area below the dredging template given to a contractor. This material has been removed from the channel, but the contractor is not paid for it, as it

was outside the template provided. The dredging contract quantities do not reflect this quantity. However, this material is captured within the annual shoaling rate calculation and this will contribute to the differences between the shoaling rates and past dredging quantities. To effectively evaluate both future required disposal capacity and project costs, two sets of shoaling rates are required. The full annual shoaling rate is used within this DMMP to ensure adequate future disposal capacity for at least the next 20 years. To more accurately calculate project costs over the life of the DMMP, a reduced annual shoaling rate was developed. The reduced rate was computed by removing the quantity of material from the annual rate that is typically dredged at no direct cost to the government while the contractor occupies the channel during dredging. Dredging records were analyzed from 1997 through 2008, and an average contract dredging duration was calculated for each reach within the navigation channel. The conversion of these durations into a percentage of a year for each reach enabled us to reduce the shoaling rate by the amount that is typically dredged at no direct cost (Table 2-9). By reducing the average shoaling rate by these amounts, we can produce a representative shoaling rate that more closely matches the quantities used to develop past dredging pumping costs. The “non-pay” quantities that result from a contractor dredging allowable overdepth as discussed above are difficult to calculate, and were not deducted from the original shoaling rate in developing the reduced rate.

The descriptions of the DMMP alternatives (Section 3, Formulation and Evaluation of Alternative Plans) include additional technical assumptions regarding the size, configuration, material requirements, in-place volume, and other parameters used to estimate quantities for development of costs and for determining specific disposal site capacities.

Range	Shoaling Rate (C.Y./Year)	Avg. Contract Duration* (days) (1997-2008)	Reduction Factor Based on Average Contract Dredged Duration	Representative Shoaling Rate (C.Y./Year) Used for Economic Evaluation
Range A Suitable	630,500	65.0	82.2%	518,000
Range A Unsuitable	118,500	12.2	96.7%	114,500
Range B	171,000	39.5	89.2%	152,500
Cutoff	324,500	70.0	80.8%	262,000
Range C Suitable	80,500	48.5	86.7%	70,000
Range C & East Leg Unsuitable	86,000	48.5	86.7%	74,500
West Leg	28,000	14.0	96.2%	27,000
Northwest Leg	80,000	45.5	87.5%	70,000
*per contract				

Table 2-9. Dredged Material Quantities Used in the Development of the DMMP

<u>Sea Level Rise</u>. In an effort to conform to Engineer Circular 1165-2-212 (USACE 2011), an analysis of the project impacts relative to increased sea levels over the life of the Morehead City Harbor DMMP was conducted. This circular requires that “potential relative sea-level change must be considered in every USACE coastal activity as far inland as the extent of estimated tidal influence.” The analysis included development of relative sea level rise projection curves, identification of potential impact areas, and associated risks, and establishing adaptive measures to adjust to future sea level rise.

Using the methods published in EC 1165-2-212, relative sea level rise curves were developed for “low,” “intermediate,” and “high” rates of future sea level change. The “low” sea level change curve is simply an extrapolation of the observed historic sea-level trend obtained at the Beaufort tide gauge station. The “intermediate” curve represents sea level rise using the National Research Council (NRC) Curve I and the “high” curve represents NRC Curve III. In addition to these required curves, an additional intermediate curve was developed between NRC Curves I and III which represented NRC Curve II.

The Beaufort tide gauge used in this analysis is a long-term data gauge with a 53-year data record used to develop the mean sea level trend seen in Figure 2-3. In addition, the Beaufort gauge is the datum used during dredging of the Morehead City Harbor navigation channel to establish mean lower low water depths. As shown in Figure 2-4, the gauge is located within approximately one mile of the navigation channel and should provide an ideal representation of historic sea level rise affecting the channel.

Figures 2-5 and 2-6 are the sea level rise curves developed in response to EC 1165-2-212. The curves cover the 20-year duration of the DMMP, beginning in calendar year 2016. Figure 2-5 contains the sea level rise curves based exclusively on the currently-estimated value for global sea level rise which is 1.7 mm/year. Presenting these curves on the same graph shows the extreme variation between the historic rates extrapolated over twenty years to the most aggressive sea level rise prediction seen in NRC Curve III. The historic rate extrapolation produced a sea level rise increase of 0.034 meters (1.34 inches) by the year 2035 while using NRC Curve III predicts a sea level rise over the twenty year project of approximately 0.183 meters (7.20 inches), or a 0.149 meter (5.87 inches) difference.

The curves shown in Figure 2-6 include the global eustatic sea level rise plus increases due to isostatic changes. The trend computed from measured historic data at the Beaufort tidal gauge represents a combination of the eustatic and isostatic changes impacting Beaufort Inlet and as such is a more appropriate tool in predicting local sea level changes. The trend established at the Beaufort gauge shows that sea level change, on average, has been 2.57 mm/year over the previous 53 years of recorded data at Beaufort Inlet. This is approximately 0.87 mm/year larger than the 1.7 mm/year value used to estimate global sea level rise. Projecting the observed sea level rise rate over the 20-year period of analysis for the DMMP shows an increase of 0.051 meters (2.01 inches) when looking at the historic curve extrapolation. The increase found using the NRC curve III projection is approximately 0.201 meters (7.91 inches). The variation of sea level change values between the historic projection and the use of NRC Curve III remains relatively unchanged at 0.15 meters (5.91 inches), the same variation predicted when using the eustatic values only.

In examining the applications and potential risks of sea level rise as it applies to this DMMP, it was found that the project has limited exposure to the effects of sea level rise and no associated risks. The project consists of dredging the Morehead City Harbor navigation channel with disposal of dredged material in the most suitable locations to minimize impacts of the dredging operations on the littoral system. The areas of the project exposed to the effects of sea level rise include: 1) increased water levels within the navigation channel; 2) increased water levels within the nearshore placement area and Ocean Dredged Material Disposal Site (ODMDS); 3) increased water levels along the adjacent beach placement areas; and 4) increased water levels along the berthing areas of the Port of Morehead City.

The exposed areas of the DMMP discussed above would have no negative impact related to sea level rise over the life of the project for several reasons. Dredging quantities within the navigation channel are determined by maintaining minimum authorized depths which vary throughout the authorized channel. Water level increases would not impact dredging quantities due to the fact that the same depths as related to mean low water would be maintained. Even though water level heights would increase over the life of the project, dredging depths would remain constant below the new mean low water surface elevations. Conversely, when considering the nearshore placement and ODMDS increased water levels would provide additional storage capability, however minor, within these areas which would be viewed as a minor benefit of sea level rise. Both the east and west nearshore placement areas extend to approximately the -17' NAVD contour, which would accommodate placement of material further landward as sea levels increase. Modification of future placements further landward as the project progresses may be necessary to continue to make efforts to place material within the active littoral zone. Along the adjacent beaches of Bogue Banks which have been established as potential placement areas for beach quality dredged material, water level increases would slightly impact the project. The design of the dredged material beach placement is partially based on the current height of the berm within the potential beach placement areas. The current berm height within this area is approximately 6' NAVD. As water levels increase over the life of the project, the berm heights within this area will naturally adjust higher to a stable profile. Future placements will need to be adjusted to the new berm heights to ensure smooth transitions between the existing beach and future beach disposals. Adjustments would not impact future costs due to the fact that surveys are obtained prior to the design of each beach disposal template using current design practices. These surveys provide all necessary information needed to accommodate the natural berm height adjustments relative to future sea level rise. The fourth potential impact of sea level rise noted was the increased water levels along the berthing areas of the Port of Morehead City. The most aggressive sea level rise projection obtained from NRC Curve III indicates an increase of 0.201 meters or nearly 8 inches at the end of the 20-year DMMP. No adjustments to the DMMP were made to account for the change of water depths at the berthing areas because one of the assumptions is that the Port of Morehead City will remain viable throughout the DMMP lifecycle. It is assumed that necessary adjustments to the Port to accommodate sea level rise will be made by the NCSPA as part of its maintenance and expansion efforts.

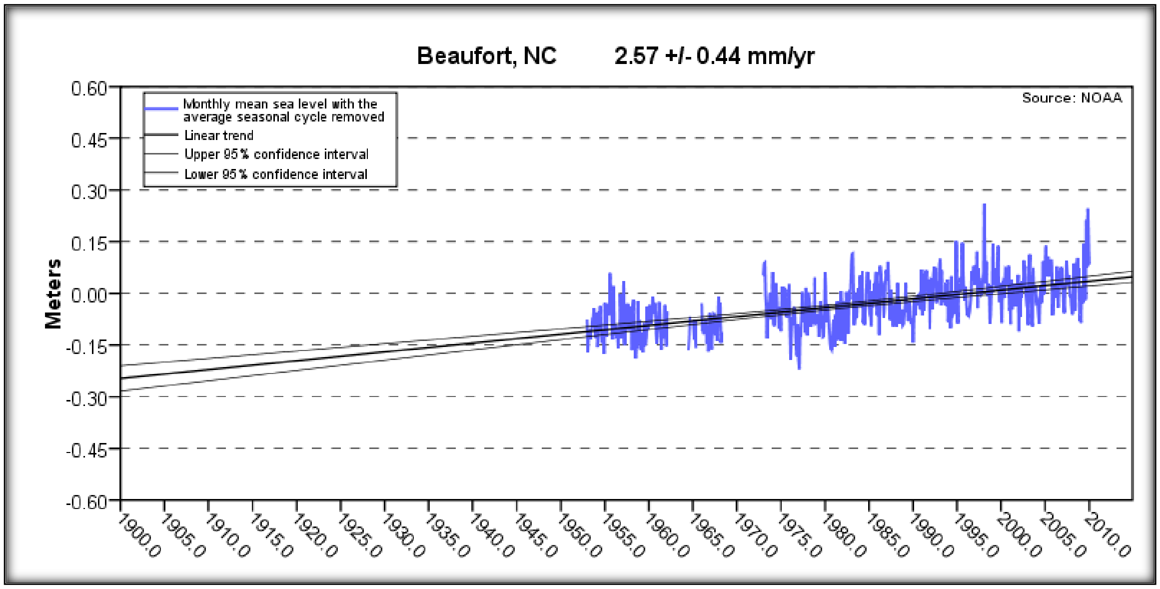


Figure 2-3. Beaufort Tidal Gauge Historic Sea Level Trend

Figure 2-4. Beaufort Tidal Gauge Location

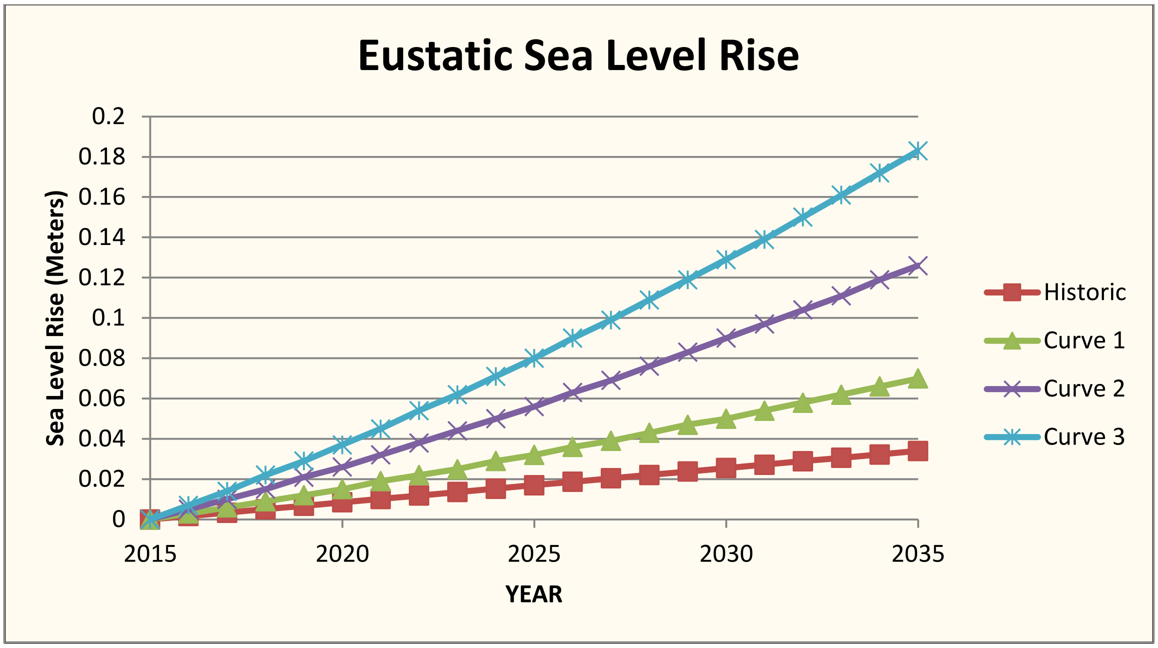


Figure 2-5. Eustatic Sea Level Rise Curves

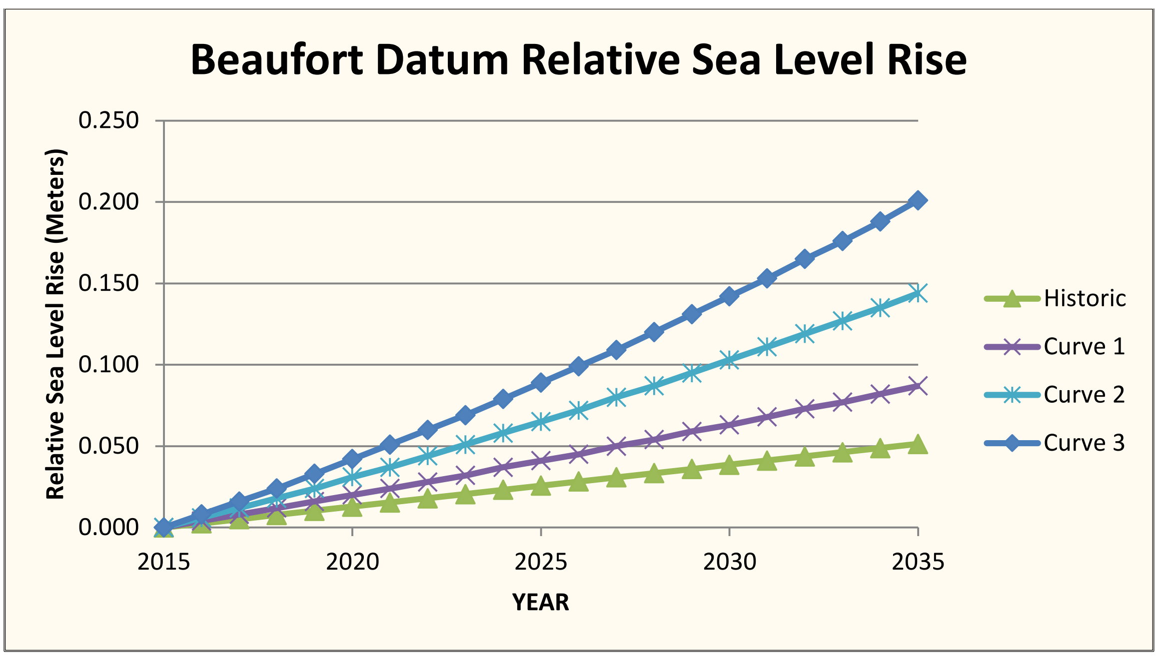


Figure 2-6. Relative Sea Level Rise Curves

2.5 Future Without Project Condition

The projected future conditions in the absence of a management plan, or the No Action Plan, represent the continued maintenance of the Morehead City Harbor without a DMMP. Until approval of the IOP in 2009, the disposal plan included disposal in and pumpout from Brandt Island. However, as evidenced by the last pumpout in 2005, Brandt Island contains large quantities of fine-grained material in addition to coarse-grained material. Due to the presence of these fine-grained sediments in Brandt Island and the high cost to separate this material from the remaining coarse-grained material, it is no longer economically feasible to do the Brandt Island pumpouts. This change in management of dredged material from the Harbor resulted in the determination that a DMMP was needed. Until the DMMP could be completed, an interim plan was implemented to address updated dredged material data and the Brandt Island issue. The IOP is the interim plan. For purposes of this report, the IOP is considered the No Action plan. This means that existing disposal practices as approved in the IOP would continue, that existing sites would not be modified or expanded, and no new sites would be constructed. The current dredged material disposal methods, as described in Section 2.1 (Existing Conditions), would continue as long as the currently-used disposal sites remain viable. In summary, all dredged material from Morehead City Harbor would continue to be disposed of in Brandt Island until it reaches capacity in 2028, on nearby beaches, in the existing nearshore placement site, or in the ODMDS.

Without the DMMP, there would be no comprehensive approach for managing dredged material or for meeting disposal needs. The DMMP identifies long-term disposal options for meeting dredged material disposal capacity needs for the Morehead City Harbor over a 20-year planning period. These disposal options comprise the least costly plan that is consistent with sound engineering practices and meets all federal environmental requirements. The DMMP complies with NEPA requirements by providing an assessment of the environmental impacts associated with implementation of the recommended dredged material management alternatives. Without the DMMP, planning for the disposal of dredged material would continue on a case-by-case basis. The following conditions may exist without the DMMP:

- Reduced reliability for navigation of the Harbor
- Less efficient budget planning
- Difficulty in maintaining adequate navigable depths in a timely manner
- Longer response time for dealing with urgent shoaling situations
- Less efficient expenditure of public funds for Harbor O&M
- Repeated regulatory compliance reviews and approvals for similar O&M activities
- Greater difficulty in identifying and evaluating cumulative environmental effects

Inefficient budgetary planning and expenditure of public funds can lead to under-funding for important programs. Inability to maintain the Harbor to authorized depths in a timely manner can negatively impact commercial and recreational usage of the Harbor and indirectly impact economic benefits to business and tourism interests. Repeated regulatory reviews and approvals for similar dredged material management activities can impact maintenance schedules and unnecessarily increase the review time commitment for regulatory agencies. Finally, continued maintenance of the Harbor without a DMMP would not meet the federal requirement that every federal navigation project have a DMMP that demonstrates dredged material disposal capacity for a minimum of 20 years.

2.6 Goals

Identification and consideration of the problems and opportunities of the study area in the context of federal authorities, policies, and guidelines resulted in the establishment of the following goals:

- Develop a 20-year plan for disposal of dredged material from Morehead City Harbor that is economically warranted, cost effective, environmentally acceptable and uses sound engineering techniques (ER 1105-2-100).

- Increase the effectiveness of navigation Operation and Maintenance funds expended.

- Develop solutions that are protective of the environment through avoidance or minimization of impacts to cultural resources and natural resources, including fisheries, invertebrates, shorebirds, marine fish, marine mammals, and their habitats.

2.7 Constraints

- Applicable federal laws

- Applicable USACE policy and guidance, including, but not limited to the following:
    - DMMPs shall be conducted pursuant to existing authorities for individual project operation and maintenance, as provided in public laws authorizing specific projects. Where management plan studies disclose the need to consider expanding or enlarging existing projects, such studies may only be pursued under specific study authority or under Section 216 of the Flood Control Act of 1970.

    - Studies of project modifications needing Congressional authorization, including dredged material management requirements related to the modification, will be pursued as cost-shared feasibility studies with General Investigations funding. Where the need for such modifications are identified as part of dredged material management studies, operation and maintenance funding for the study of the modification should be terminated and a new feasibility study start sought through the budget process under the authority of Section 216 of the Water Resources Development Act (WRDA) of 1970.

3 ALTERNATIVES

3.1 No Action Plan (No DMMP)

The “No Action” alternative is used as a basis for comparison to the recommended or base plan. Because the study goal is to develop a plan to ensure dredged material disposal capacity for at least the next 20 years, the consequences of no action (i.e. no plan to ensure sufficient dredged material disposal capacity from 2016 to 2035) are particularly important because they define the need for the DMMP.

Until approval of the IOP in 2009, the disposal plan included disposal in and pumpout of coarse-grained material from Brandt Island. The Brandt Island pumpout served two purposes; it renourished local beaches and restored capacity in Brandt Island. When that plan was no longer feasible, it was determined that a DMMP was needed and an interim plan was implemented to address updated dredged material data and the Brandt Island issue. The IOP is the interim plan. Although the IOP is intended to be an interim plan, it is the only plan that has been approved by resource agencies and stakeholders. Implementation of the IOP beyond the three years for which approval was obtained has required further coordination, but only results in a three-year approval.

The No Action Plan would neither ensure that a 20-year disposal capacity exists for maintenance of Morehead City Harbor, nor ensure that disposal was being accomplished in the least costly manner, consistent with sound engineering practices and meeting environmental standards. Additionally, continuing to return sand to one side of the inlet, when both sides are losing sand, is not a good long-term engineering practice.

3.2 Formulation of DMMP Measures

Pursuant to 33 C.F.R. § 335.4, the USACE undertakes operations and maintenance activities where appropriate and environmentally acceptable. All practicable and reasonable alternatives are fully considered on an equal basis. This includes the discharge of dredged or fill material into waters of the U.S. or ocean waters in the least costly manner, at the least costly and most practicable location, and consistent with engineering and environmental requirements. Pursuant to 33 C.F.R. § 335.7, we conduct our navigation according to the Federal Standard, which is the dredged material disposal alternative or alternatives identified by USACE which represent the least costly alternatives consistent with sound engineering practices and meeting the environmental standards established by the 404(b)(1) evaluation process (Appendix H) or ocean dumping criteria.

The objective of the DMMP is to provide the least cost, engineeringly sound, environmentally acceptable alternative for disposal of maintenance dredged material from Morehead City Harbor for at least the next 20 years. Beneficial uses of dredged material are powerful tools for harmonizing environmental values and navigation purposes. It is the policy of the USACE that all dredged material management studies include an assessment of potential beneficial uses for environmental purposes including fish and wildlife habitat creation, ecosystem restoration and enhancement and/or coastal storm damage reduction. Several of the measures considered for the DMMP represent beneficial uses of dredged material.

This section presents a detailed description of the measures that have been developed for evaluation in the DMMP, and a brief description of measures that were eliminated from further study and the justification for their elimination. The Morehead City Harbor plans were formulated and categorized based on various sediment types and their location within the Harbor. As shown in Figure 2-2, the Harbor ranges have been divided into three categories: (1) fine-grained material less than 80% sand; (2) material that is between 80% and 90% sand and; (3) material that is greater than or equal to 90% sand.

On March 4, 2009, a public meeting was held to brief attendees on the Morehead City Harbor DMMP project and process, to solicit comments and input, and to invite attendees to participate on the Project Delivery Team (PDT). Attendees included representatives from state and federal resource agencies, interest groups, and stakeholders. Several attendees expressed an interest in participating on the PDT and have actively participated in the development of the DMMP. The PDT members are listed in Section 13 (Project Delivery Team). In addition to the public meeting and involvement by various resource agencies and stakeholders in the planning process, the USACE has also coordinated with the National Park Service regarding potential DMMP measures that may impact Cape Lookout National Seashore and in February 2011, NPS formally became a cooperating agency on the DMMP (Appendix D). Additional information regarding coordination is included in Section 5.1, NEPA Documentation and Coordination, and copies of all pertinent correspondence are found in Appendix D. Following identification of problems and opportunities, the PDT identified 21 potential DMMP measures (Table 3-1) for the Morehead City Harbor DMMP which resulted in over 100 dredging and disposal options to be analyzed for inclusion in the base plan (Tables 3-16 thru 3-20). Table 3-1 also identifies the beneficial use options that were considered. Analysis and screening of the measures during the plan formulation process resulted in the elimination of several of the disposal measures. The measures that remain feasible are described in detail in the following sections and are the basis for the proposed base plan. Those measures that were eliminated are discussed in Sections 3.2.6 (DMMP Measures Eliminated) and in Section 3.5.1 (Trade-Off Analysis) and were not further analyzed.

	Morehead City Harbor DMMP Alternatives & Measures	
#	**Description**	**Beneficial Use**
1	**No Action (No DMMP)**	NA
2	**Proposed DMMP (Measures Considered)**	NA
a	Brandt Island upland disposal site	No
b	Place coarse-grained material (≥90% sand) on Bogue Banks	Yes
c	Morehead City Ocean Dredged Material Disposal Site (ODMDS)	No
d	Expand nearshore (ebb tide delta) placement area west of Beaufort Inlet	Yes
e	Create nearshore (ebb tide delta) placement area east of Beaufort Inlet	Yes
f	Place Inner Harbor material ≥80% sand in nearshore placement areas	Yes
g	Expand and raise Brandt Island dike	No
h	Raise existing Brandt Island dike (no expansion)	No
i	Transfer Brandt Island material to ODMDS to regain capacity	No
j	Recycle Material in Brandt Island through Hydrocyclone Density Separation	Yes
k	Place coarse-grained material (≥90% sand) on Shackleford Banks	Yes
l	Continue to use existing nearshore placement area (no expansion)	Yes
m	Modify environmental windows	No
n	Construct colonial waterbird islands	Yes
o	Dispose of dredged material in Radio Island	No
p	Dispose of dredged material in Marsh Island	No
q	Use dredged material to create wetlands	Yes
r	Construct new upland disposal site	No
s	Brandt Island shoreline stabilization	Yes
t	Construct jetties at Beaufort Inlet	No
u	Modify existing groin on west side of Beaufort Inlet	No
v	Realign channels to improve navigation and reduce dredging	No

Table 3-1. Morehead City Harbor DMMP Alternatives and Measures

3.2.1 Brandt Island

Brandt Island is approximately 168 acres in size and located south of the existing Port of Morehead City, across the Morehead City Harbor Channel (Figure 1-3). The Island has been used as a disposal area since 1955 and is divided from the Bogue Banks barrier island by the narrow Fishing Creek. Immediately to the southeast is the Fort Macon U.S. Coast Guard facility and Fort Macon State Park.

Brandt Island is owned and has previously been used as a sand-recycling site by the North Carolina State Ports Authority and dedicated for the purpose of dredged material disposal. Brandt Island has a present capacity of about 3 million cubic yards. In 1986, 1994, and 2005 approximately 3.9 million, 2.5 million, and 2.9 million cubic yards, respectively, of dredged material were pumped out of Brandt Island and disposed of on the beaches of Bogue Banks from Fort Macon State Park to Atlantic Beach.

Brandt Island has historically received material that is both suitable and unsuitable for beach disposal. In 2005 a cross dike was constructed inside Brandt Island at an elevation of 14 feet mean sea level (msl) for purposes of segregating the unsuitable material from the coarse-grained material suitable for beach disposal. However, as previously stated, due to the problems associated with the last Brandt Island pumpout in 2005, since that time, only fine-grained dredged material has been disposed of in Brandt Island. Coarse-grained material has been placed on the beaches of Fort Macon State Park and Atlantic Beach, in the existing nearshore placement area west of Beaufort Inlet (Nearshore West), in the ODMDS, or on Pine Knoll Shores (Figure 1-5, west of Atlantic Beach) as part of a beneficial use of dredged material project (Section 933). There are no plans for future pumpouts from Brandt Island to the beach.

The existing Brandt Island disposal area encompasses approximately 64 acres and has a controlling top of dike elevation of approximately 37 feet msl. It is assumed that 2 feet of freeboard will be required at all times during disposal operations and water and dredged material will not be allowed above elevation 35 feet msl within the disposal area. The existing available storage volume below elevation 35 feet msl is approximately 3 million cubic yards.

<u>Management of Brandt Island</u>**.** Brandt Island is currently being operated in a one-cell configuration with only fine-grained material from the Inner Harbor being disposed of there. The PDT considered modification of future disposal practices at Brandt Island, by only disposing of fine-grained silty material from portions of the Northwest and West Legs in Brandt Island rather than using it for disposal of all material from the Inner Harbor, including all of the East Leg and North Range C. The eastern half of the West Leg (referred to as West Leg 2) and North Range C contain a mix of fine-grained and coarse-grained material that is ≥80% sand. Because these portions of Inner Harbor contain higher percentages of sandy material than other areas of the Inner Harbor, the draft DMMP evaluated an option to keep this sandy material in the littoral system by

placing it in the Nearshore West (existing and expanded) and in the proposed nearshore placement area off of Shackleford Banks (Nearshore East). Due to comments received on the draft DMMP that disfavored use of 80%-90% sand in nearshore areas, this option has been eliminated. It is expected that Brandt Island will reach capacity in 2028. This is based on disposal of the following approximate quantities: 15,000 cubic yards annually from the non-federal berths, 512,000 cubic yards from the federal channel every 3 years, and 75,000 cubic yards from the Fort Macon Coast Guard Station every 6 years. Potential measures that would extend the life of Brandt Island were considered as discussed below. Two dike alignments with varying dike heights were analyzed. One option considered dike raises to elevations 42’, 47’, 52’ and 55’ along the present alignment. However, as discussed in Section 3.2.6, DMMP Measures Eliminated, raising the dikes along the current alignment is not economically justified. Other measures considered an expanded alignment with dike raises also to elevations of 42’, 47’, 52’ and 55’. An expanded dike would have the standard 15-foot top width and 3 horizontal to 1 vertical side slopes. The dike alignment would be adjusted as needed to minimize the amount of fill required. The toe of the expanded dike alignment would be designed to avoid wetlands and to also allow a construction buffer (work area) adjacent to the toe. Specific information for the subsurface investigation, lab testing, dike design, and the stability analysis are contained in the Geotechnical Appendix B.

3.2.2 Beach Placement

Area of Inlet Influence. As part of the Morehead City Dredged Material Management Plan (DMMP) it is necessary to establish the areas along the adjacent beaches that are influenced by the ebb tide delta of Beaufort Inlet. This zone of influence is used to determine the future placement limits for material dredged from the system, with the intention of maintaining the health of the ebb tide delta and retaining material within the natural littoral zone. Determination of the zone of influence was established at the positions along both beaches where it appeared the profile had reached equilibrium and consistent offshore closure was found.

Figure 3-1 displays the approximate limits of the inlet influence area along Bogue Banks. Based on review of surveys taken in April 2001, the influence of Beaufort inlet seems to end approximately between stations 59 and 60. Inset into Figure 3-1 are three figures showing a close-up view of an area near the inlet, Inset A; a magnified view of the west end of the inlet influence area, Inset B; and a magnified view of the center of the inlet area of influence, Inset C. These inset figures show the -20, -25, and -30 feet contours and the approximate distances between the contours at each end of the inlet influence area. Inset A shows the contours with a large amount of separation between them as well as significant curvature of the contour lines. Inset B shows that in this area the contours are relatively straight and parallel to the shoreline with much less distance separating the contours when compared with inset A. The profile graph included in Figure 3-2 displays profiles along Bogue Banks from Profile 107 near the inlet through Profile 59. To improve clarity, not all profiles within the area of inlet influence are displayed; however, the profiles chosen show the gradual steepening of the offshore portion of the profile as they progress west. The onshore portion of the beach seems to be at a relatively stable slope throughout this area, indicating that the steepening of the offshore portion of the profile is not translating to the shoreline. Consistent offshore closure is reached in the region of profiles 59 and 60, approximately 10.5 miles west of Beaufort Inlet. This area of influence from Beaufort Inlet is significantly farther west than the location of the sediment transport rate nodal point identified in the USACE Section 111 Report (USACE, 2001), which concluded the nodal point is located about 2.3 miles west of the inlet. Further monitoring of profile change within this region of inlet influence is needed to determine if the influence area is reducing due to deflation of the ebb tide delta.

The inlet area of influence for Shackleford Banks is shown in Figure 3-3. The same methodology used to determine the influence zone for Bogue Banks was used in determining the zone for Shackleford Banks, however, the survey used was more recent June 2008 data (Geodynamics, 2008). The analysis showed that consistent depth of closure was reached between profiles 293 and 249, approximately 4 miles east of the inlet. This location almost exactly matched the location of the sediment transport rate nodal point, which was found to be approximately 3.75 miles east of the inlet in the Section 111 Report (USACE, 2001).

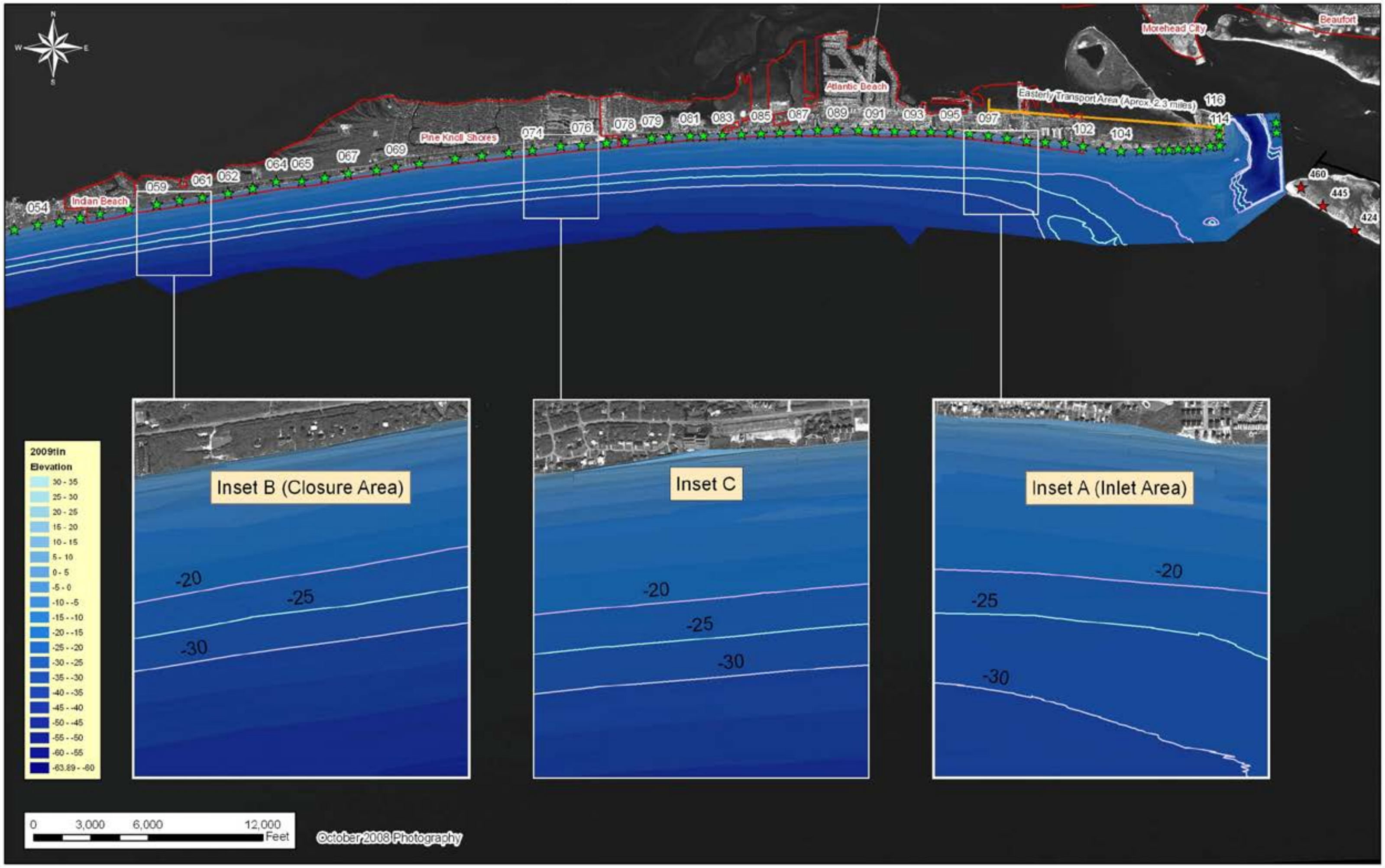


Figure 3-1. Bogue Banks Area of Inlet Influence

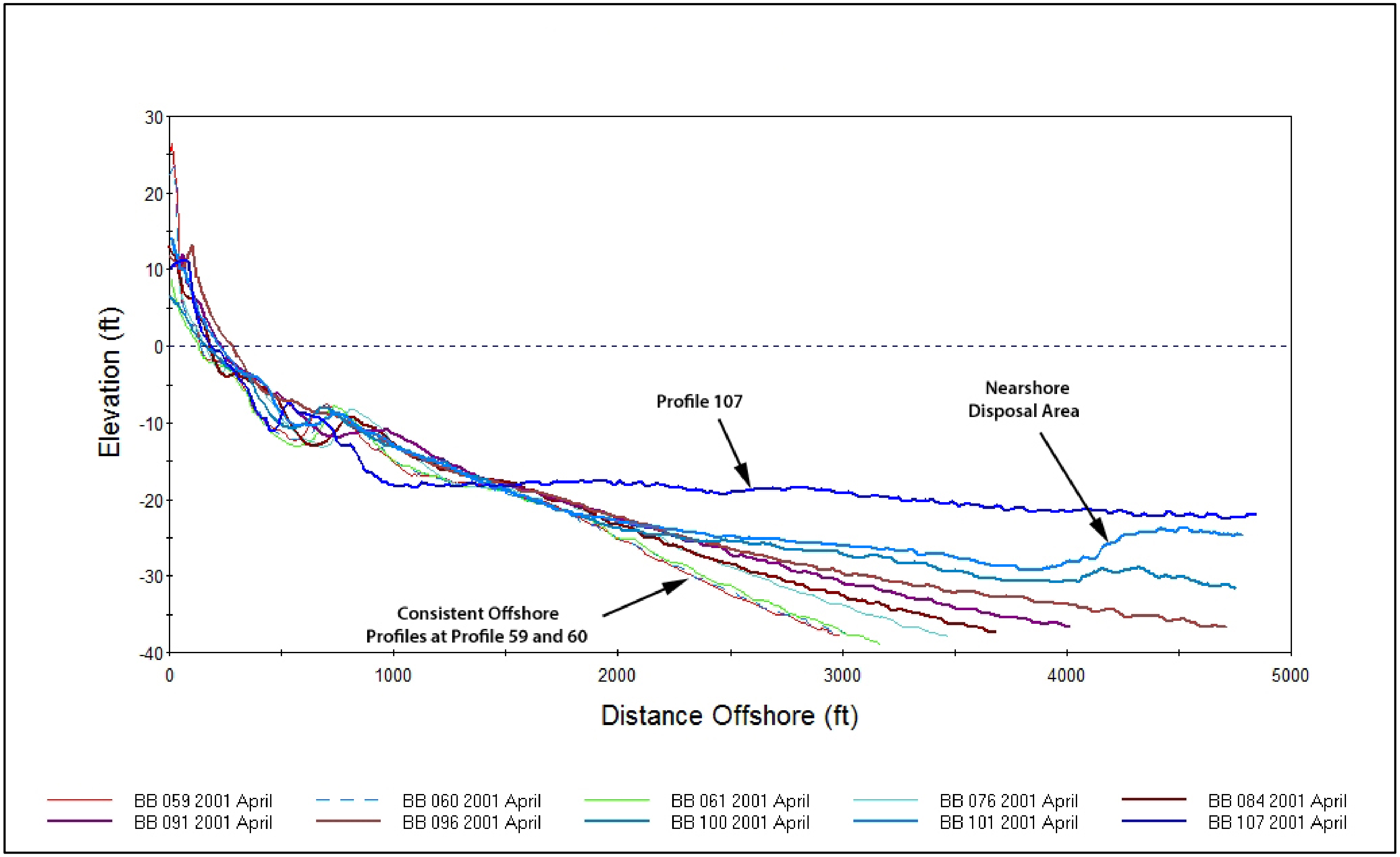


Figure 3-2. Bogue Banks Profiles

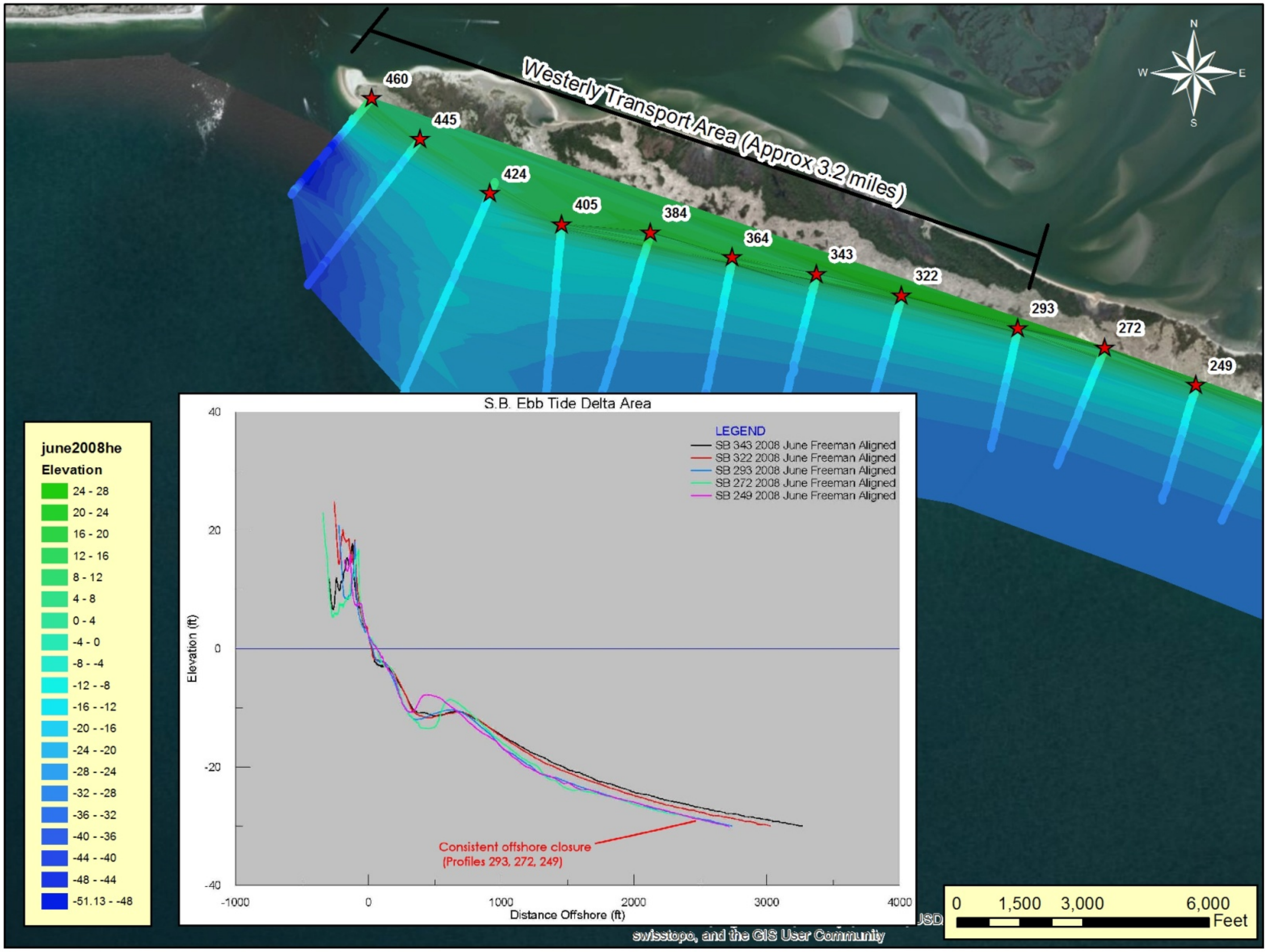


Figure 3-3. Shackleford Banks Area of Inlet Influence

One measure which has been used historically for disposal of coarse-grained material (greater than or equal to 90% sand) dredged from the Morehead City navigation channel is beach placement along various sections of Bogue Banks. One reason for this was to offset potential impacts to the adjacent shorelines by placing some of the coarse-grained material on the beach. In the Winds, Waves, and Shore Processes appendix of the USACE 1976 General Design Memorandum for deepening of portions of the project to 42 feet, it was determined that "channel deepening has definitely decreased natural by-passing of sediment across the Beaufort Inlet Ocean Bar" (USACE 1976). At that time, although the primary erosive effects of the deepening were thought to be experienced on Shackleford Banks, the decision was made to periodically pump Inner Harbor material from Brandt Island onto the Atlantic Beach shoreline. This was done in order to offset potential impacts of the navigation project to beachfront development along Bogue Banks. The amount to be pumped out, an anticipated annual equivalent of 135,000 cubic yards a year, was predicted to be "sufficient to stabilize" the Atlantic Beach shoreline. It should be noted that Shackleford Banks is managed by the National Park Service (NPS). Although new information regarding navigation channel impacts on Shackleford Banks has caused the NPS to investigate the beach disposal option in compliance with its policies, disposal of material on Shackleford Banks was previously considered not consistent with NPS Management Policies (2006). Therefore no material has been disposed of there to date. The 2001 Section 111 Report examined whether the Morehead City Harbor project had adversely impacted adjacent beaches and concluded that placement of sand on the beaches of Fort Macon State Park and Atlantic Beach was "an integral part of the operation and maintenance of the project," and that the placement of approximately 5 million cubic yards of material between 1978 and 2001 "provided more than adequate compensation or mitigation for this possible impact" (USACE 2001).

Material has been placed on Bogue Banks in various locations on 11 occasions by the USACE since the deepening of the channel in 1978. The total quantity placed to date by the USACE is approximately 16,900,500 cubic yards and is summarized in Table 3-2.

Placement	Channel Depth	Date	Quantity	Location	Source
1	-40 feet m.l.w	1978	1,179,600	Ft. Macon State Park Shoreline	Navigation Channel
2	-40 feet m.l.w	1986	4,168,637	Eastern 3.6 miles of Atlantic Beach	Brandt Island/Navigation Channel
3	-45 feet m.l.w	1994	4,664,400	Ft. Macon and Atlantic Beach	Brandt Island/Navigation Channel
4	-45 feet m.l.w	2002	209,300	Ft. Macon	Navigation Channel
5	-45 feet m.l.w	2004	776,000	Salter Path/Indian Beach	Navigation Channel
6	-45 feet m.l.w	2004/2005	2,920,729	Ft. Macon and Atlantic Beach	Brandt Island
7	-45 feet m.l.w	2007	509,566	Pine Knoll Shores	Navigation Channel
8	-45 feet m.l.w	2007	184,828	Eastern Ft. Macon	Inner Harbor
9	-45 feet m.l.w	2008	148,393	Just west of Atlantic Beach Town Li	AIWW
10	-45 feet m.l.w	2010/2011	1,346,700	Ft. Macon and Atlantic Beach	Navigation Channel
11	-45 feet m.l.w	2013/2014	792,354	Ft. Macon and Atlantic Beach	Navigation Channel

Table 3-2. Summary of Dredged Material Placement on Bogue Banks

As part of the DMMP, an evaluation of possible placement locations and quantities along Bogue and Shackleford Banks was made. The premise of the evaluation was to determine the annual volume loss of the eastern end of Bogue Banks between stations

77 and 112 (Figure 3-4) and along the western end of Shackleford Banks between stations 293 and 460 (Figure 3-5), some of which could be related to the dredging of the navigation channel. These loss rates were used to determine the optimal quantity from future dredging events to ameliorate the future losses computed on the eastern and western ends of the adjacent islands. The area along Bogue Banks analyzed to determine volumetric change was established based on the historic beach placement areas for the navigation project. The USACE Section 111 report (USACE, 2001) determined that the historic beach placement activities have more than ameliorated any shoreline impacts that may be related to the dredging of the navigation channel. Additionally, the Section 111 report determined that there were no significant changes to the shoreline recession rate beyond the Atlantic Beach town limits that are related to the navigation project. As a result of this determination, mitigation for the remainder of the island was not warranted. The region of the beach along Shackleford Banks used to determine associated volumetric losses was determined based on the results from the sediment transport studied included in the Section 111 report. This study found that rates were predominately westerly through the western 16,600 feet of the island. Beyond this distance there was some variation between easterly and westerly transport. The 16,600 foot distance approximately corresponds to the area between stations 293 and 460 along Shackleford Banks. The following volumes computed for these areas do not separate volume loss resulting from the navigation channel from the loss that would naturally occur with no project in place. Given the length of time that the navigation project has been in place at Beaufort Inlet, there was insufficient data available pre-project to determine the natural background erosion rate. As a result, the loss volumes calculated and corresponding beach disposal quantities are conservative.

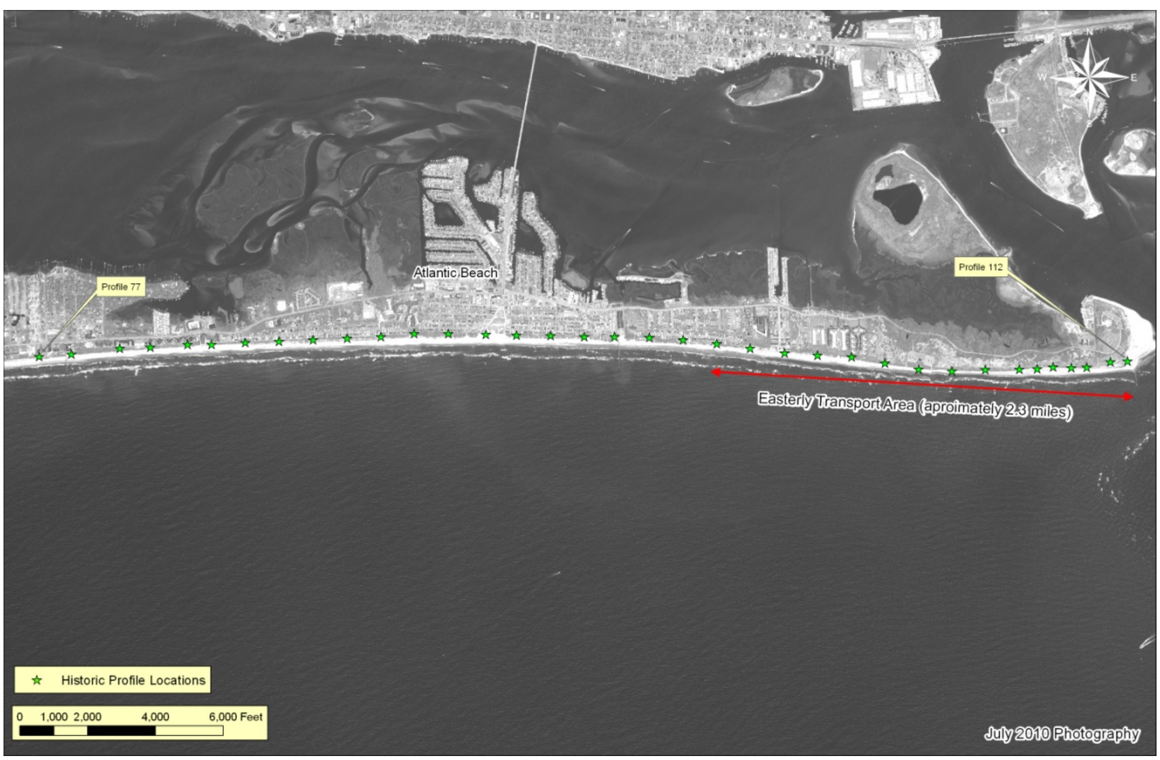


Figure 3-4. Bogue Banks Volumetric Analysis Area

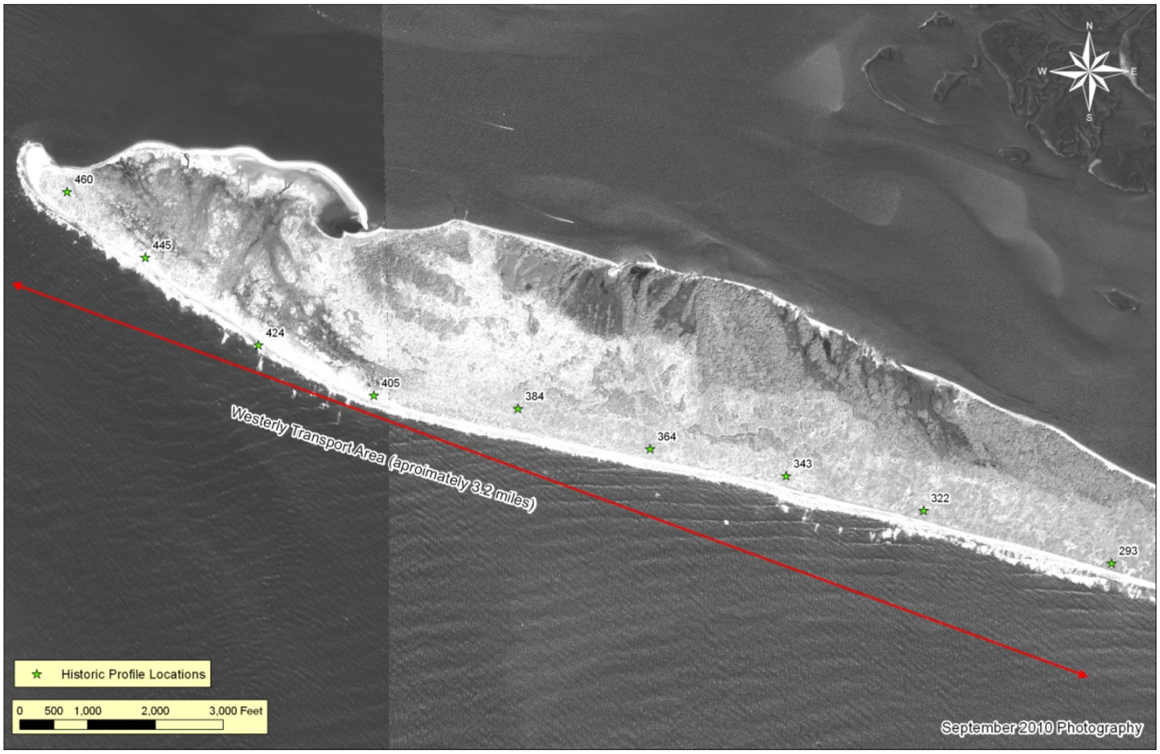


Figure 3-5. Shackleford Banks Volumetric Analysis Area

Volumetric analysis of the east end of Bogue Banks, including Atlantic Beach and Fort Macon shorelines, was based on a collection of eight surveys including: December 2003, June 2004, May 2005, May 2006, May 2007, July 2008, June 2009 and the most recent survey of June 2010. Surveys within this area are typically spaced 1000 feet apart on the beachfront portions of the island with a tighter typical spacing of 500 feet near the inlet complex. Offshore coverage typically extends to approximately 2000 feet offshore; offshore coverage is greater with the most recent surveys (since 2006) extending out to 2500 feet and beyond (Figure 3-6).

The beach profile surveys were analyzed using BMAP (Beach Morphology Analysis Program) (Sommerfield 1994) to determine unit volume changes over time for each profile of interest. Volumes were calculated between landward and seaward points common to all surveys at the individual profile locations. These locations varied along the beach depending on the available survey coverage.

To illustrate trends in volume change within the eastern end of Bogue Banks, Figure 3-7 shows the volume change over time with respect to the base year survey of December 2003. The values for each displayed time period within the graph are the total measured volume changes for the eastern end of the island included in the analysis (Station 77-112) relative to December 2003. This type of plot allows comparison of volumetric changes over time as well as comparison of volumetric changes from survey to survey. To account for a small disposal of material (184,828 cubic yards) along the beach at Fort Macon, this quantity was subtracted from all volumetric measurements for each of the surveys following the March 2007 disposal. Two things are clearly shown within Figure 3-7. The first is the impact of the Brandt Island pumpout which occurred between November 2004 and February of 2005 and placed nearly 2.4 million cubic yards of sand along Bogue Banks. The result of the placement was an increase in volumetric quantities within the analysis area as related to the December 2003 survey.

The second item that is clear from Figure 3-7 is the substantial loss of material along the eastern end of the island following the Brandt Island pumpout operation through June 2009. The most recent survey in June 2010 shows a slight increase in volume within this area, reversing the most recent trend. Losses within the region between the first post-fill placement survey and the most recent survey of June 2010 show that the area has lost approximately 916,600 cubic yards of material in total. Due to the limited number of historic surveys along the existing baseline stationing scheme prior to the beach placement in 2004, the loss rate for the area was computed using the May 2005 through June 2010 surveys exclusively. This was done by computing a least-squares regression through the volumetric data for these years. The results of the regression analysis found that the area of Atlantic Beach and Fort Macon is eroding material at a rate of approximately 218,800 cubic yards per year.

Figure 3-8 displays the volumetric changes since December 2003 for each profile within the volumetric analysis area for Bogue Banks. This plot clearly shows the influence of the 2004 beach placement and the subsequent erosion of the material. Volumetric change displayed within the figure shows that a section of the western end of the analysis area (Stations 93-104) has eroded rapidly following the beach placement while the surrounding areas have remained somewhat stable following placement. This area of more rapid erosion is approximately centered on the nodal transport zone identified in the Section 111 report. The stability of the surrounding areas may be related to the diffusion of material disposed of between Stations 93 and 104 toward the eastern and western ends of the area of interest.

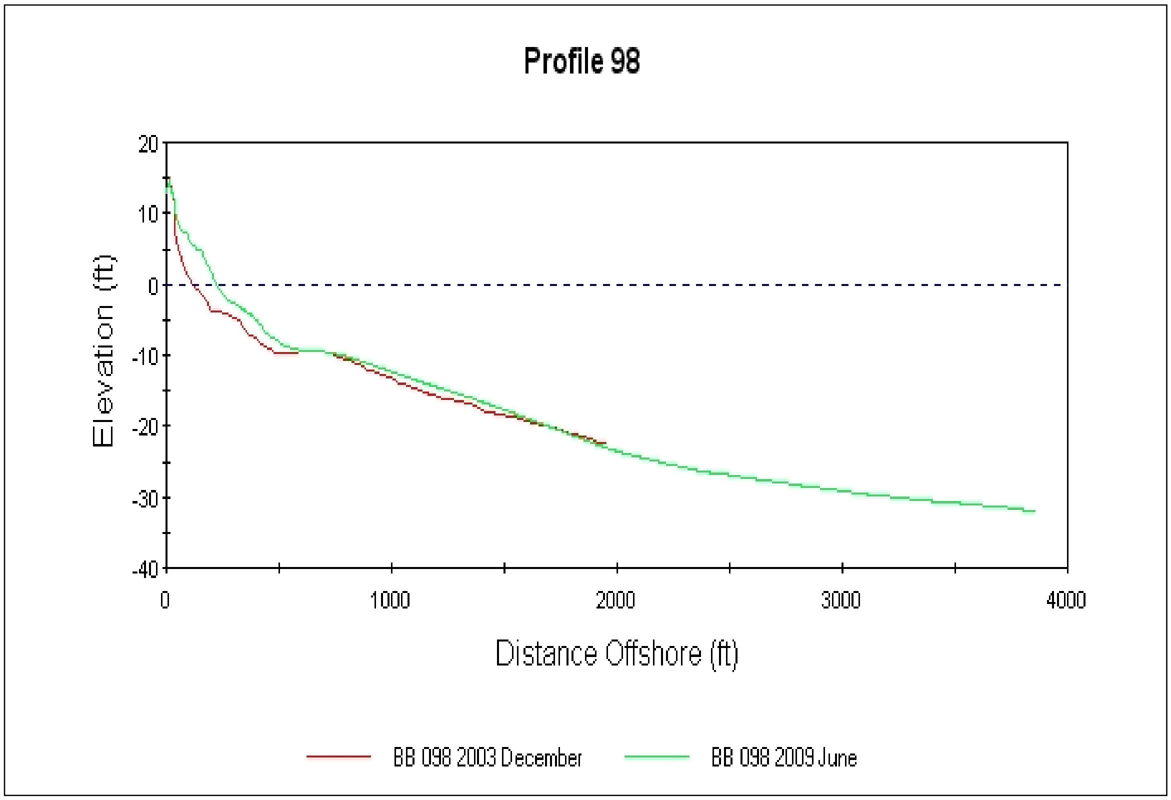


Figure 3-6. Typical Survey Coverage

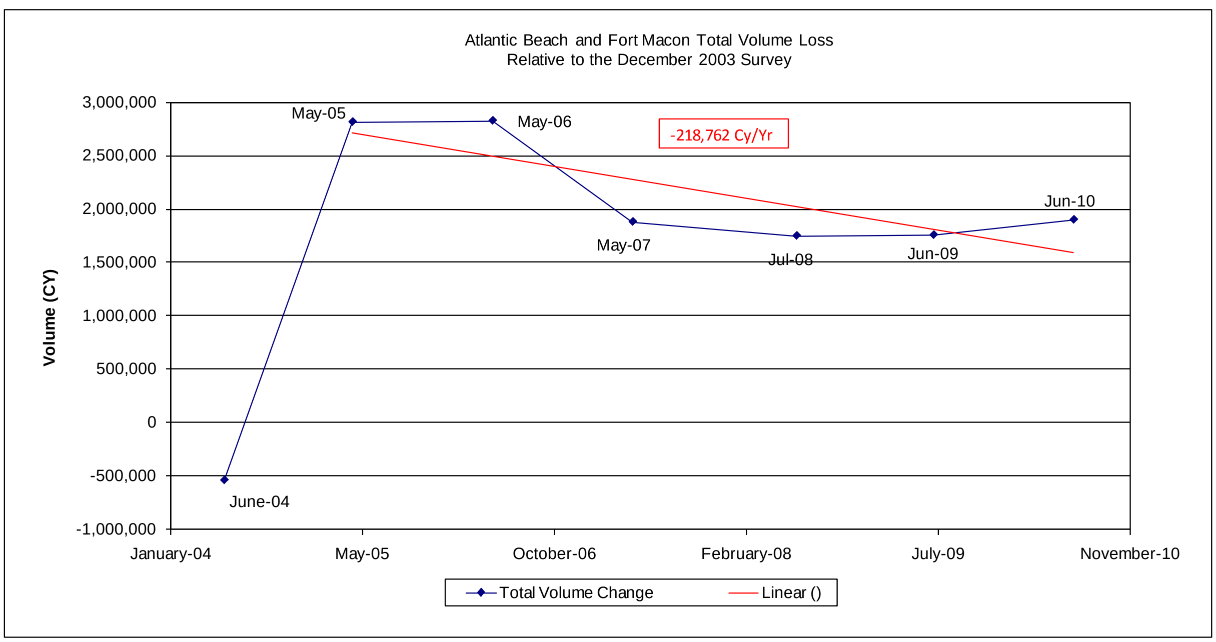


Figure 3-7. Bogue Banks Total Volume Loss (Stations 77-112)

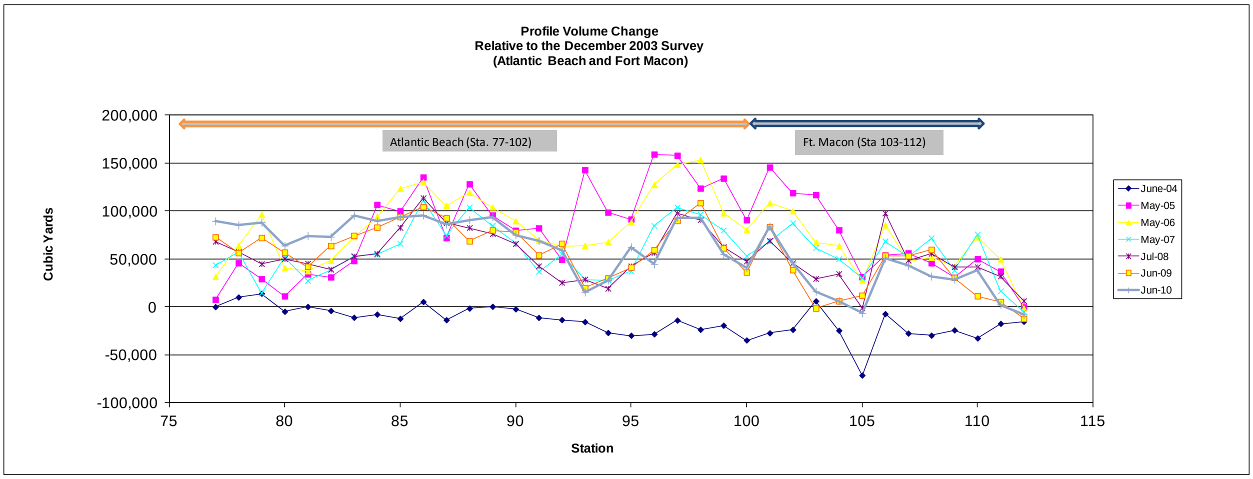


Figure 3-8. Bogue Banks Volume Loss by Station

Volumetric analysis of Shackleford Banks is based on a more limited survey database, consisting of only five surveys. The surveys included in the analysis were the October 2000, May 2006, June 2008, August 2009, and the April 2010 survey, which had relatively consistent onshore and offshore coverage. The spacing of the profile coverage along Shackleford Banks is more irregular than on Bogue Banks with the spacing varying between 1,500 and 2,700 feet. Offshore extent of the survey coverage varies from approximately 2,700 feet to more than 5,000 feet with coverage being greater near the inlet and reducing toward the middle of the island (Figure 3-9). The beach profile surveys at Shackleford Banks were analyzed in the same way the profiles along Bogue Banks were analyzed. Volumes were calculated between landward and seaward points common to the surveys at each profile location above a common datum. To develop the annual volumetric change along the western end of the island (Stations 293 to 460), the computed volumes were compared and plotted relative to the base year condition of October 2000 (Figure 3-10). These calculations show that the area between Stations 293 and 460 included in this analysis has lost approximately 1,516,800 cubic yards of material since the base year survey of October 2000. As seen in Figure 3-10, the western end of Shackleford Banks has lost material each year surveyed, with no indication of stabilization as recently observed along the western end of Bogue Banks. A least-squares regression computed through these computed volumetric changes shows the loss is approximately 166,450 cubic yards per year over the 9.5 years included in the analysis.

Figure 3-11 displays the volumetric changes relative to the October 2000 survey for each profile along Shackleford Banks. From this plot it is clear that the majority of the island has experienced a net loss of material since October 2000, with the most significant erosion occurring in the western portion of the island at Station 424. The eastern end of the island, between Stations 41 and 59, has actually experienced volumetric increases since October 2000.

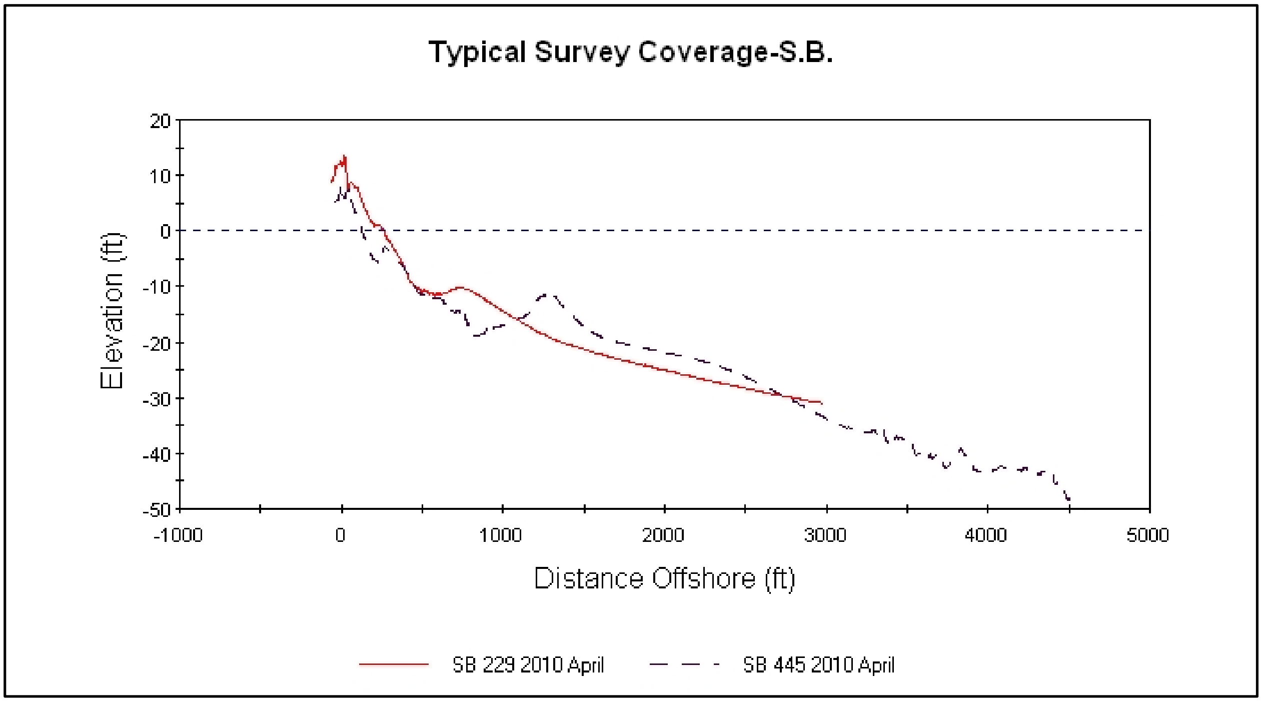


Figure 3-9. Shackleford Banks Typical Survey Coverage

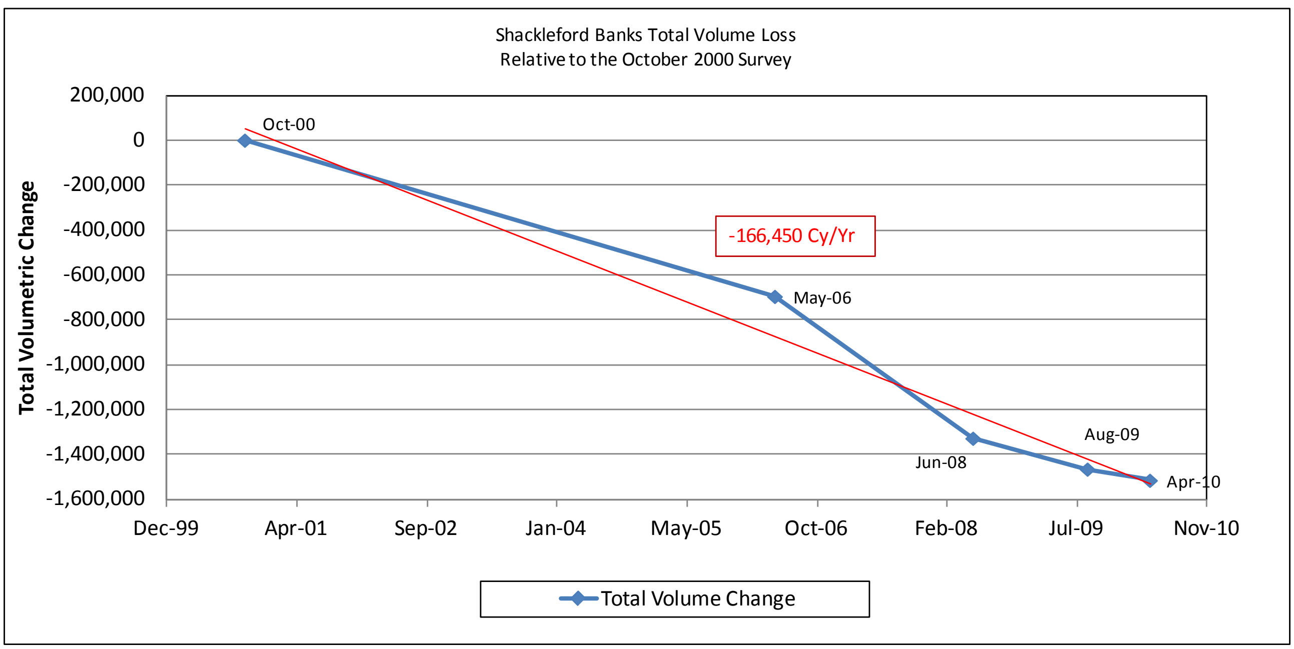


Figure 3-10. Shackleford Total Volume Loss (Stations 293-460)

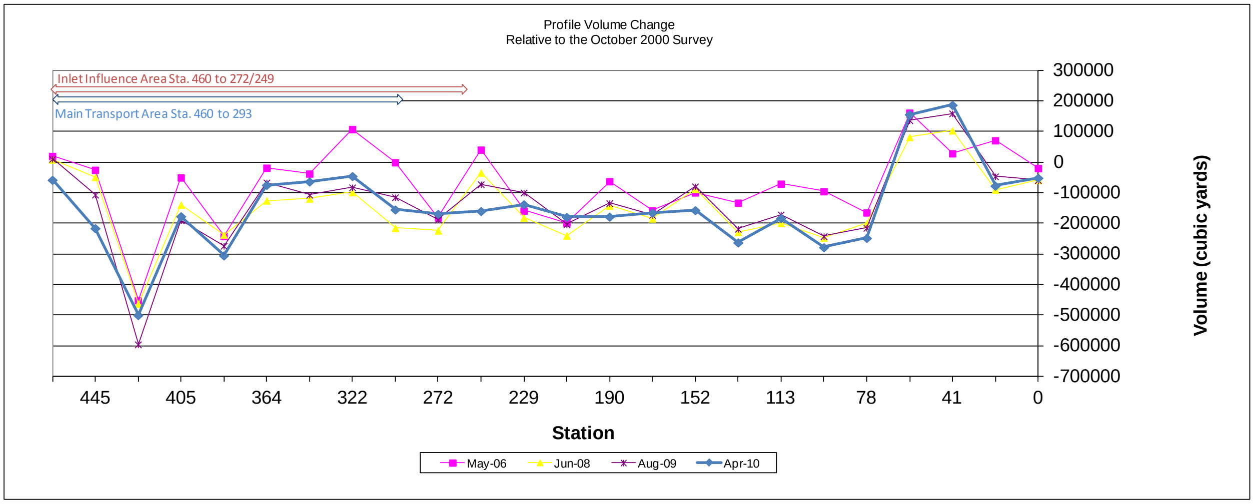


Figure 3-11. Shackleford Banks Volume Loss by Station

The current recommendation for future beach placement operations along Bogue Banks is that such placement should be based on the volumetric loss within the area of Atlantic Beach and Fort Macon, subject to reasonable cost and pumping distance limitations. It is recommended that future beach disposal operations place material primarily between Stations 77 and 107 (Figure 3-12) as the base location. Material in excess of the amount needed to offset losses between stations 77 and 107 would likely be disposed of farther west in areas within a reasonable pumping distance that have experienced a loss of material. The quantity and location of future disposal events will be based on changes observed through the monitoring program and should be sufficient to ameliorate non-storm-induced losses that have occurred between beach disposal operations. Dredged material quantities and placement locations will be subject to navigation priorities and the limitations of available funding for dredging the navigation channel and will fluctuate from year to year. On occasion, local interests may fund, through an Additional Work Memorandum of Agreement (MOA), the movement of the placement area to areas within the Inlet Influence area that are farther west than the USACE would typically place that material with federal funds.

Although the NPS has declined placement of sand on Shackleford Banks, such placement was analyzed as part of this DMMP, and the results and recommendations of the USACE regarding such placement are provided in this document as a record of those USACE recommendations.

Disposal of material along the beaches of Shackleford Banks should also be based on the volumetric loss measured between placement events. Figure 3-13 displays the potential area designated for placement of beach quality sand. The potential placement area is slightly east of the area used to determine volumetric changes. This eastward offset is necessary to reduce rapid shoaling of the material directly back into the navigation channel while still providing sufficient beach length to place the necessary quantities. Material placed of within this area would be subject to the predominant westerly transport rates which will naturally move material toward the westernmost part of the island that does not receive sand.

Future placement of material within the designated limits along Shackleford Banks would be monitored to measure its impact on shoaling rates within Beaufort Inlet. Adjustments to fill quantities and placement locations within the designated areas along Shackleford Banks would be made to minimize impacts on inlet shoaling patterns. Although this analysis recommends placement of sand on Shackleford Banks to reduce impacts from the maintenance dredging of Beaufort Inlet, the NPS has requested that no beach-quality dredged material be placed on Shackleford Banks as part of this DMMP; therefore all beach quality sediment will be placed on the previously described area of Bogue Banks during beach placement events (typically every three years).

Comparison of the volumetric losses calculated earlier in this section shows that the recent loss trends for both islands are relatively similar. The loss rate for the Bogue Banks side of the inlet is approximately 218,800 cubic yards per year, while a similar loss rate along Shackleford Banks of 166,450 cubic yards per year was also calculated. These annual losses, when converted to percentages, show that 57% of the material is lost from the Bogue Banks side of the inlet, and 43% of the total losses come from the Shackleford Banks side. With this approximate 57/43 split of sediment entering the navigation channel from both the east and west, material should be returned to the beaches in similar ratios during future beach placement operations. Following the initial placements, these ratios would have been reevaluated based on the performance of the material placed. This reevaluation would have occurred just prior to future disposal events to ensure equitable distribution of available material to both islands. The National Park Service (NPS) is the agency responsible for the management of Shackleford Banks, and initially determined that only the quantity of material lost from the island as a result of the navigation channel can be returned to the beaches of Shackleford Banks. Based on the NPS initial decision, quantities for the initial fill would have been determined based on discussions with the NPS prior to dredging operations and would not have exceeded the three-year historic loss rate volume of 499,350 cubic yards. The maximum amount of material that would have been placed along the beaches of Shackleford Banks following the initial fill would have been the historic volumetric erosion rate of 166,450 cy/year multiplied by the duration between beach placement events, with the potential that any dredged quantities in excess of that amount could be placed west of the described base placement area on Bogue Banks (Station 77-107). Figure 3-12 also displays the extended beach placement area for any excess material, which is between Stations 59 and 76 on Bogue Banks. Specific locations for placement west of the Bogue Banks base location would be determined just prior to the commencement of dredging activities to determine the area that produces the greatest benefits while minimizing associated pumping costs. While the recommended sediment split described above remains the recommended plan, with the decision by the NPS to not allow placement on Shackleford Banks during beach placement years, all coarse-grained dredged material will be placed on the beaches of Fort Macon State Park and Atlantic Beach.

Another factor that will be considered when developing quantities to be placed along the eastern end of Bogue Banks is the migration of the spit at the eastern end of the island. Recent aerial photography indicates that the spit has experienced significant growth since 1996 and appears to be migrating east toward the navigation channel. Growth of the spit in relation to beach fill should be monitored. Adjustments may be needed in the placement locations of material within the easterly transport zone if it appears that material placed along the beach is migrating toward and attaching to the spit which may cause restrictions within the navigation channel.

Figure 3-12. Proposed Bogue Banks Placement Area

Figure 3-13. Proposed Shackleford Banks Placement Area

3.2.3 Ocean Dredged Material Disposal Site (ODMDS)

The transportation and disposal of dredged material in ocean waters, including the territorial sea, is regulated under the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA) (Public Law 92-532, 86 Stat. 1052, 33 U.S.C. §§1041 et seq.) as amended by Title V of the Water Resources Development Act of 1992 (WRDA 92; Public Law 102-580). Section 102(a) of MPRSA authorizes the USEPA to establish and apply regulations and criteria for ocean dumping activities. Consequently, the USEPA issued in October 1973, and revised in January 1977, Ocean Dumping Regulations and Criteria (40 CFR 220-238). These regulations establish control of ocean dredged material disposal primarily by two activities: designation of sites for ocean dumping, and the issuance of permits for dumping.

The MPRSA Section 102(c) authorizes USEPA to designate recommended sites for ocean dredged material disposal sites. An ocean dredged material disposal site (ODMDS) is a precise geographical area within which ocean disposal of dredged material is permitted or authorized under conditions specified in MPRSA Sections 102 and 103. The designation of an ocean dredged material disposal site by EPA is based on compliance with general (Section 228.5) and specific (Section 228.6(a)) site evaluation criteria. Final site designation under MPRSA Section 102(c) must be based on environmental studies of each site and on historical knowledge of the impact of dredged material disposal on areas similar to such sites in physical, chemical, and biological characteristics. The USEPA has the primary responsibility for site designation. A site may be selected by the USACE under MPRSA Section 103(b), with USEPA concurrence, if no USEPA designated site is available.

The transportation of dredged material for the purpose of disposal into ocean waters (i.e. the actual use of the designated site) is permitted by USACE (or authorized in the case of federal projects) under MPRSA Section 103(e), applying environmental criteria established in USEPA's Ocean Dumping Regulations and Criteria. MPRSA Section 104(a)(3) provides that ocean disposal of dredged material can occur only at a designated site. Section 103(b) requires the USACE to utilize dredged material disposal sites designated by USEPA to the maximum extent feasible. Prior to issuing a dredged material permit or authorizing a federal project involving the ocean disposal of dredged material, the USACE must notify USEPA, who may disapprove the proposed disposal.

The U.S. Coast Guard (USCG) is assigned responsibility under MPRSA to conduct surveillance of disposal operations to ensure compliance with permit conditions and to discourage unauthorized disposal. The USCG recognizes that the USACE has the primary surveillance and enforcement responsibilities over federally-contracted actions associated with federal navigation projects. The USCG retains responsibility for surveillance of activities not associated with federal navigation projects.

<u>Morehead City Ocean Dredged Material Disposal Site (ODMDS)</u>. The Morehead City ODMDS (Figure 1-5) was designated by USEPA pursuant to Section 102(c) of the Marine Protection, Research, and Sanctuaries Act of 1972, as amended, as suitable for the ocean disposal of dredged material. The final rule was promulgated by USEPA on 14 August 1987 (52 FR 30360), effective 14 September 1987. The boundary coordinates (NAD 27 Geographic) for the Morehead City ODMDS are:

34^0 38'30" N 76^0 45'00" W
34^0 38'30" N 76^0 41'42" W
34^0 38'09" N 76^0 41'00" W
34^0 36'00" N 76^0 41'00" W
34^0 36'00" N 76^0 45'00" W

The site is located just beyond 3 nautical miles offshore (beyond 3 nautical miles from the baseline of the territorial sea) of Morehead City, North Carolina. The Morehead City ODMDS has an area of about 8.0 square nautical miles. Depths within the ODMDS range from about -30 to -55 feet local mean low water (mlw) based on a composite of bathymetric surveys which include data from 1995 to 2011. Depths are shallowest in the northern (inshore) portion and gradually deepen to the south (offshore). Approximately 60% of the area is deeper than -50 feet (mlw). The bathymetry is essentially flat except for slight mounds of dredged material in the northeast third and middle of the ODMDS due to previous dredged material discharges and the influence of the Beaufort Inlet ebb tide delta.

Material was excavated from the Morehead City ODMDS by Carteret County as a borrow source for nourishment of the Bogue Banks beaches in 2004, 2007, and 2013 following Hurricanes Isabel, Ophelia, and Irene, respectively. Approximately 1.2 million cubic yards of sand were removed from the northeast corner of the Morehead City ODMDS during those two events by hopper dredges and pumped onto the Bogue Banks beaches.

Disposal of dredged material in the ocean has been associated with the Morehead City Harbor federal navigation project for many years. Federal dredging projects in Morehead City Harbor began in 1910. Continued use of the Morehead City Harbor navigation channel depends on annual maintenance dredging. Only one non-federal maintenance dredging and ocean dredged material disposal permit (permitted pursuant to Section 103 of MPRSA) has taken place in the Morehead City Harbor area, that being associated with the State maintained portions (berths) of the North Carolina State Ports.

The placement of dredged materials in the ocean off Beaufort Inlet since 1995 is documented in Table 3-3.   Estimated volumes in Table 3-3 were derived from vessel disposal records provided by dredging contractors for ocean placement verification. They are not based on channel surveys. Since 1987 (the date of site designation) ocean disposal of dredged materials from the Morehead City Harbor federal project channels has occurred in the Morehead City ODMDS. Beginning in 1995, sediments dredged during the maintenance of the Morehead City Harbor navigation channels were also placed in the Morehead City Harbor Nearshore Placement Area off Bogue Banks, or more infrequently, directly on Bogue Banks beaches. The nearshore placement area is discussed further in Section 3.2.4. Accordingly, the quantity of dredged material being transported to the ODMDS for disposal has declined as compared to the pre-1995 levels.

As mentioned above, the Morehead City ODMDS has been used as a borrow area for Bogue Banks beach replenishment. Sand from the ODMDS has been dredged and subsequently discharged as beach fill. Future use of dredged material from the ODMDS for beach replenishment is possible.

Bathymetric surveys have indicated that the sandy and coarse dredged materials historically disposed of within the Morehead City ODMDS have the potential to mound appreciably when specific areas are repeatedly used for disposal. Such mounds may limit future use of specific areas of the ODMDS, and may pose impairment to navigation including use by hopper dredges. These limitations should be minimized to the extent possible.

Morehead City ODMDS	
Calendar Year	**Quantity (Cubic Yards)**
1987	544,000
1988	691,000
1989	539,000
1990	592,000
1991	832,000
1992	209,000
1993	628,000
1994	715,000
1995	636,000
1996	0
1997	1,143,000
1998a	270,000
1998b	210,000
1999	759,000
2000	150,000
2001	719,000
2002	0
2003	283,000
2004	0
2005	63,000
2006	469,000
2007	537,000
2008	406,000
2009	681,000
2010	0
2011	436,000
2012	132,000
2013	75,000
TOTAL	**11,719,000**

Table 3-3. Morehead City ODMDS Site Use by Year.
(Note: Volumes prior to 2007 are based on ocean disposal reporting, not survey or contract pay volumes. Volumes after 2007 were derived from contract records.)

Morehead City ODMDS Site Management**.** As documented in the Site Management and Monitoring Plan (SMMP) dated February 2010 (USEPA and USACE 2010), all ocean disposal at the Morehead City ODMDS must be conducted in accordance with the applicable Ocean Dumping Regulations and Criteria found in 40 CFR Parts 220-238, whether conducted as a permit activity or as a federal activity. The following are

Morehead City ODMDS management requirements, and all permits or evaluation concurrence shall be conditioned to include these requirements.

Dredged Material Evaluation. Only dredged materials which have been evaluated in accordance with USEPA's Ocean Dumping Regulations and Criteria and found in compliance with those criteria will be transported for disposal in the Morehead City ODMDS (USEPA/USACE 2010). Guidance for evaluation of dredged materials under the MPRSA Section 103 program is provided in the Evaluation of Dredged Material Proposed for Ocean Disposal - Testing Manual, February 1991 and the Regional Implementation Manual, Requirements and Procedures for Evaluation of the Ocean Disposal of Dredged Materials in Southeastern Atlantic and Gulf Coastal Waters, 2008. The determination of dredged material suitability for ocean disposal must be documented in a MPRSA Section 103 evaluation and approved by USEPA Region 4 prior to disposal. Dredged materials will be reevaluated for suitability for ocean disposal in accordance with current USACE/USEPA guidance at an interval not to exceed three years. Reevaluation and testing procedures will be coordinated with the Wilmington District USACE and USEPA Region 4 before any sampling or testing is undertaken.

Dredged Material Suitable for Beneficial Uses. “Beneficial uses” refers to the concept that dredged material can be disposed in a way that is economically and environmentally acceptable and accrues environmental, economic or other benefits to society.

Coarse-grained dredged material (sands) from the navigation channel should be placed on nearby beaches or within the littoral system when it is the least cost, engineeringly sound, environmentally acceptable option. Due to the large area of the ODMDS (8 square nautical miles), ODMDS dredged material capacity is not an issue and should not be for the foreseeable future. However, site capacity and mounding factors are favorably affected by not placing coarse-grained material in the ODMDS. Other beneficial uses of dredged materials are also encouraged pending appropriate environmental review.

As discussed previously, dredged material was excavated from the Morehead City ODMDS by Carteret County for sand replenishment of the Bogue Banks beaches in 2004, 2007, and 2013. Approximately 2.2 million cubic yards of historically placed Morehead City Harbor dredged material were removed from the northeast corner of the Morehead City ODMDS during those three events by hopper dredges and then pumped out onto the Bogue Banks beaches. This repository for dredged material provided good quality sand and facilitated access for the beach replenishment. When feasible, all coarse-grained material from the Morehead City Harbor channels will be placed in the nearshore placement areas or on the beaches of Fort Macon and Atlantic Beach . However, should circumstances ever warrant the disposal of coarse-grained material from the Harbor in the Morehead City ODMDS, disposal of those materials would be directed to a portion of the ODMDS where access and potential opportunities for recycling and beach nourishment are facilitated (Figure 1-5). Accordingly, the northern half of the Morehead City ODMDS is restricted to dredged material that is coarse-grained. Conversely, fine-grained materials may not be discharged there.

The sediment testing described in Appendix B confirmed the Harbor channel areas where fine-grained materials occur. Continued ocean disposal of these dredged materials is likely as other disposal/placement options, including beneficial uses, are either not available or not feasible. As discussed previously, only materials evaluated and found in compliance with the USEPA's Ocean Dumping Regulations and Criteria can be transported to the ocean for disposal. The Morehead City Harbor navigation channel sediments have been tested in accordance with USEPA regulations and criteria and dredged material from all reaches of the Harbor is acceptable for disposal in the ODMDS. In order to minimize interference with potential use of beach-quality sand for beach replenishment, the fine-grained sediments dredged from Morehead City Harbor navigation channel will be placed in the far southwest corner of the Morehead City ODMDS as shown on Figure 1-5. Fine-grained sediments that may be disposed of in the ODMDS would come from the Morehead City Inner Harbor or the Outer Entrance Channel.

Dredged Material With Debris. If significant quantities of debris (either wood or man-made) are present in the dredged materials, then debris management should be conducted. Significant quantities of debris are considered to be those which would materially interfere with fishing in areas near the Morehead City ODMDS, or interfere with re-use of dredged material from within the ODMDS (i.e., beach nourishment borrow material). Debris management may involve the following:

- Removal of the debris from the dredged material before transportation to the ODMDS;
- Disposal of dredged material in the ODMDS in a location (e.g., farthest distance possible from the fishing areas or borrow areas) such that debris interference is unlikely;
- Immobilizing the debris within the ODMDS by covering it (capping) with dredged material.

Methods of Disposal. Disposal is typically accomplished by hopper dredge or dump scow. For each disposal project, a specific area within the ODMDS will be designated for use and a specific disposal pattern will be prescribed. Dredged materials will be discharged within the ODMDS boundaries. Dredged material disposal will not be allowed closer than 600 feet from the site boundary. The disposal of dredged materials outside the ODMDS boundaries is not acceptable under MPRSA authorities. An approved ocean disposal verification plan must be carried out. Disposal methods that minimize mounding of dredged material within the designated disposal area will be required.

Disposal Quantities. Quantities of dredged materials disposed of within the ODMDS will be limited to those amounts that do not produce unacceptable adverse effects to human health and welfare, the marine environment, or human uses of that environment (as defined in USEPA's Ocean Dumping Regulations and Criteria). The disposal quantity management objective for the Morehead City ODMDS is to regulate disposal quantities such that depths in the disposal area following disposal do not interfere with navigation. The disposal depth limitation will be -30 feet mlw. Current average depths in the ODMDS are approximately -45 to -50 feet mlw.

Timing of Disposal. There are no seasonal restrictions to the disposal of dredged material within the Morehead City ODMDS. However, seasonal restrictions and seasonal special requirements may apply to particular dredging activities at particular locations. Refer to Section 3.2.5 for a discussion of dredging windows.

Channel Area. If the alignment of the Morehead City Harbor Range A channel is extended seaward, it crosses the eastern border of the ODMDS. In order to provide safe navigation, dredged material disposal will not be allowed within approximately 1000 feet of the current limits of the channel. This area where the navigation channel intersects the ODMDS is shown on Figure 1-5. Disposal of dredged material in this area will be allowed only after a review by Wilmington District USACE in consultation with USEPA Region 4 and only if a determination is made that the proposed disposal will specifically not interfere with navigation.

3.2.4 Ebb Tide Delta

To aid in the development of the DMMP, an analysis of changes within the Beaufort Inlet ebb shoal complex was completed. The results of the analysis will help determine placement quantities and locations of material dredged from the adjacent navigation channel. An understanding of potential impacts to the ebb tide delta is important because changes to the complex may eventually impact adjacent beaches.

3.2.4.1 Ebb and Nearshore Shoal Analysis

Bathymetric Data Collection. Bathymetric data were available from four different survey periods for the Beaufort Inlet complex: June 1974 National Oceanographic and Atmospheric Administration (NOAA) Survey, September 1998 NOAA Survey, a June 2005 survey provided by the NC Division of Coastal Management through Geodynamics, LLC, and an April 2009 survey contracted through the USACE, Wilmington District. The reference datum used for the bathymetric comparison was the North American Vertical Datum of 1988 (Appendix E, Explanation of Vertical Datum). The use of this datum required conversion of the NOAA data from its mean low water reference datum to a reference datum of NAVD 88. After conversion, data from the 2005 North Carolina Division of Coastal Management (NCDCM) survey were observed to be deeper than corresponding data from the 2009 Beaufort Inlet survey in the offshore portion of the profile. Discussions with the surveyor revealed that the 2005 DCM survey data when collected was processed with an incorrect heave and speed of sound correction calculation within the software. The errors occurred during collection of the data and therefore a raw data file without errors was not available for processing. To compensate for these errors and keep the survey in the data set, a section of data in the offshore portion of the survey on the east side of the navigation channel was used to create an adjustment factor. Data differences in this area, beyond the depth of closure, were averaged and an adjustment of +0.95’ was applied to the entire 2005 inlet survey. One additional NOAA survey from March of 1953 was excluded from the analysis due to what appeared to be a datum error associated with the survey in the offshore portion of the profile.

Bathymetric Changes. Coverage of the ebb tidal delta for Beaufort Inlet is shown in Figure 3-14 from the most recent survey of May 2009. From this survey, gross patterns of seafloor morphology are evident. These include the Ocean Dredged Material Disposal Site (ODMDS) in the southwest corner of the bathymetry, the nearshore placement area located west of the navigation channel approximately 1 mile offshore, the inlet ebb tide delta split by the Morehead City navigation channel, and a minor flood channel on the west side of Beaufort Inlet. Also visible in the photo is apparent scour in the east lobe of the ebb tide delta that appears to be caused by ebb currents attempting to re-align the channel from a north-northeast alignment to more of a north-northwest orientation. Further modeling of currents within the region is needed to confirm.

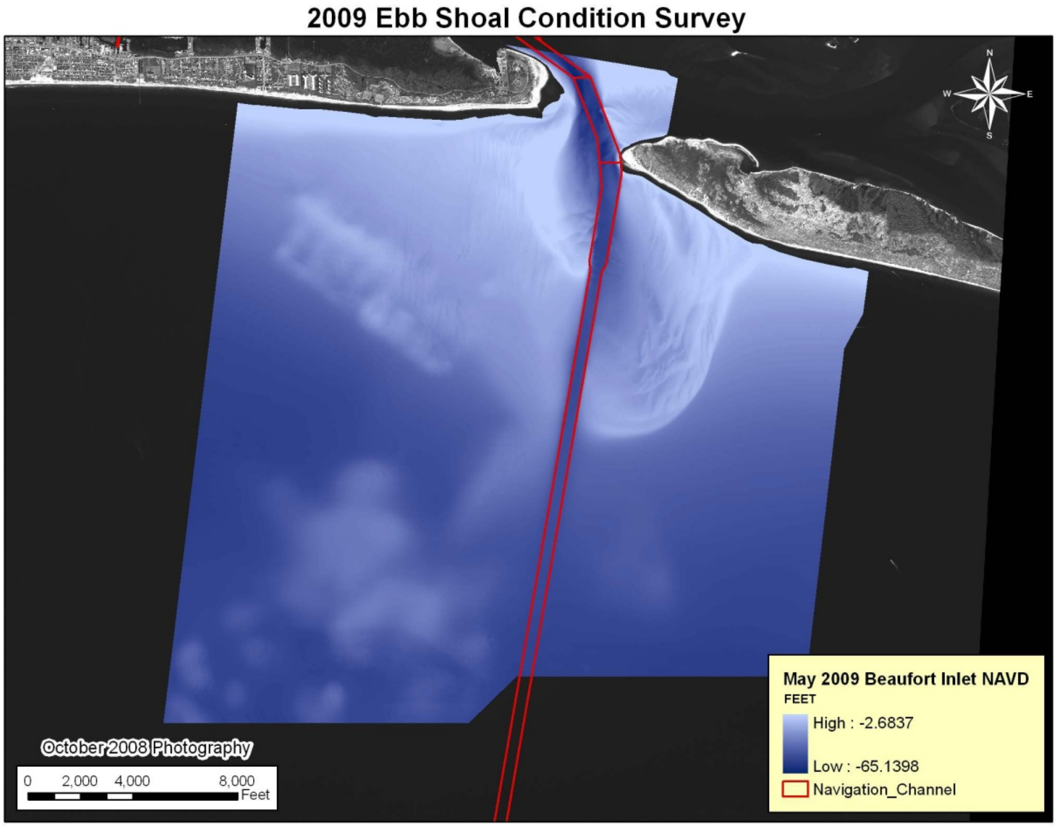


Figure 3-14. Current Ebb Shoal Conditions at Beaufort Inlet

Comparisons between surveys were made by generating maps showing changes in the bathymetry over time. These difference maps were contoured in 2-foot intervals with changes between -2 and 2 feet not displayed to improve visual clarity of the map. Figure 3-15 is a difference plot showing the differences in bathymetry from our earliest available inlet survey in June 1974 with the September 1998 survey. The majority of changes that occurred during our study period of 1974 to 2009 are shown in this difference plot. The plot indicates that extensive erosion occurred over a majority of both the east and west halves of the inlet ebb tide delta, with the erosion in the west side of the delta ranging from 3 to 7 feet, while the erosion on the east side of the navigation channel ranged from 6 to 12 feet. There appeared to be four major exceptions to what occurred in the majority of the ebb tide delta region. The first was an erosional hot spot located just west of the northernmost visible portion of the navigation channel. This area experienced extensive vertical erosion of up to 38 feet. This could be the result of material sloughing off this point into the Cutoff portion of the navigation channel, which is dredged on a routine basis. Due to the regular dredging of the Cutoff section, which removes the foundation of this point, the bank is not able to stabilize and should continue to erode until an equilibrium slope is reached. The second exception to the general erosion of the ebb tide delta area is just east of the northernmost visible portion of the navigation channel. This area has accreted as much as 16 feet. While it is difficult to determine the cause of the accretion in this area, it could be related to the erosion observed on the west side of the Inlet with possible bypassing of sand past the navigation channel building up the shoal just off Shackleford Banks. To further investigate both of these areas, modeling of the system currents would be needed. The third exception to the general trends of the ebb tide delta is the obvious nearshore placement area (Nearshore West) located west of the navigation channel, approximately 1 mile offshore. This area is discussed later in this report, including a detailed examination of historic placement and sediment movement within the nearshore placement area. The last major exception is the shoaling that has occurred in the southern portion of the eastern half of the ebb tide delta. This area of the delta has shoaled up to 19 feet and has extended this half of the delta nearly 2000 feet seaward when compared to the 1974 survey. This appears to be related to the ebb currents attempting to straighten the navigation channel from its dredged orientation of north-northeast to more of a north-northwest orientation. This appears to be the predominant cause of the deflation of the eastern half of the ebb tide delta.

Figure 3-16 is a difference plot showing the changes between September 1998 and June 2005 that occurred within the same bounding area as in Figure 3-15. Most of the trends observed in the comparison of the 1974 to 1998 data continued into this time period. The eastern half of the ebb tide delta continued to experience an overall deflation; the western half seems to have stabilized, with only a few areas showing erosion greater than 2 feet. The erosion hot spot located on the west side of the northernmost visible portion of the navigation channel continued to erode and even increased in area. The shoaling on the opposite side of the navigation channel from this erosional hot spot, while still occurring, decreased and moved farther offshore from the point at Shackleford Banks. The Nearshore West Placement Area has increased in size due to continued placement of material farther south as the initial placement cells filled with material. The final area showing change was the southernmost portion of the eastern ebb delta. This area continued to grow south, away from Shackleford Banks. The growth area observed between 1974 and 1998 actually eroded up to 7 feet during the time period of 1998-2005, which indicates that the currents continued to push material over the eastern shoal in an attempt to straighten the navigation channel.

Figure 3-17 displays the bathymetric change that occurred during the period of June 2005 through April 2009. The same trends established during previous analysis periods continued into this most recent time period, although to a lesser extent. The western lobe of the ebb tide delta appeared relatively stable, with significant change occurring only in the offshore portion of the Nearshore West Placement Area. The inlet throat continued its erosive pattern into this period with the area of erosion continuing to expand. The eastern lobe of the ebb tide delta showed continued erosion throughout the majority of the area, with accretion at the offshore edge of the analysis area. This remains consistent with trends previously observed, however the accretion in the offshore area was lower in both magnitude and area. Figure 3-18 shows the cumulative changes previously discussed for the time period 1974 to 2009. The figure clearly shows the extensive areas within the ebb tide delta which have eroded. Also visible in the figure are the areas of accelerated erosion and accretion occurring near the inlet throat, the gains in the nearshore placement area, and the accretion and expansion of the offshore portion of the east ebb tide delta.

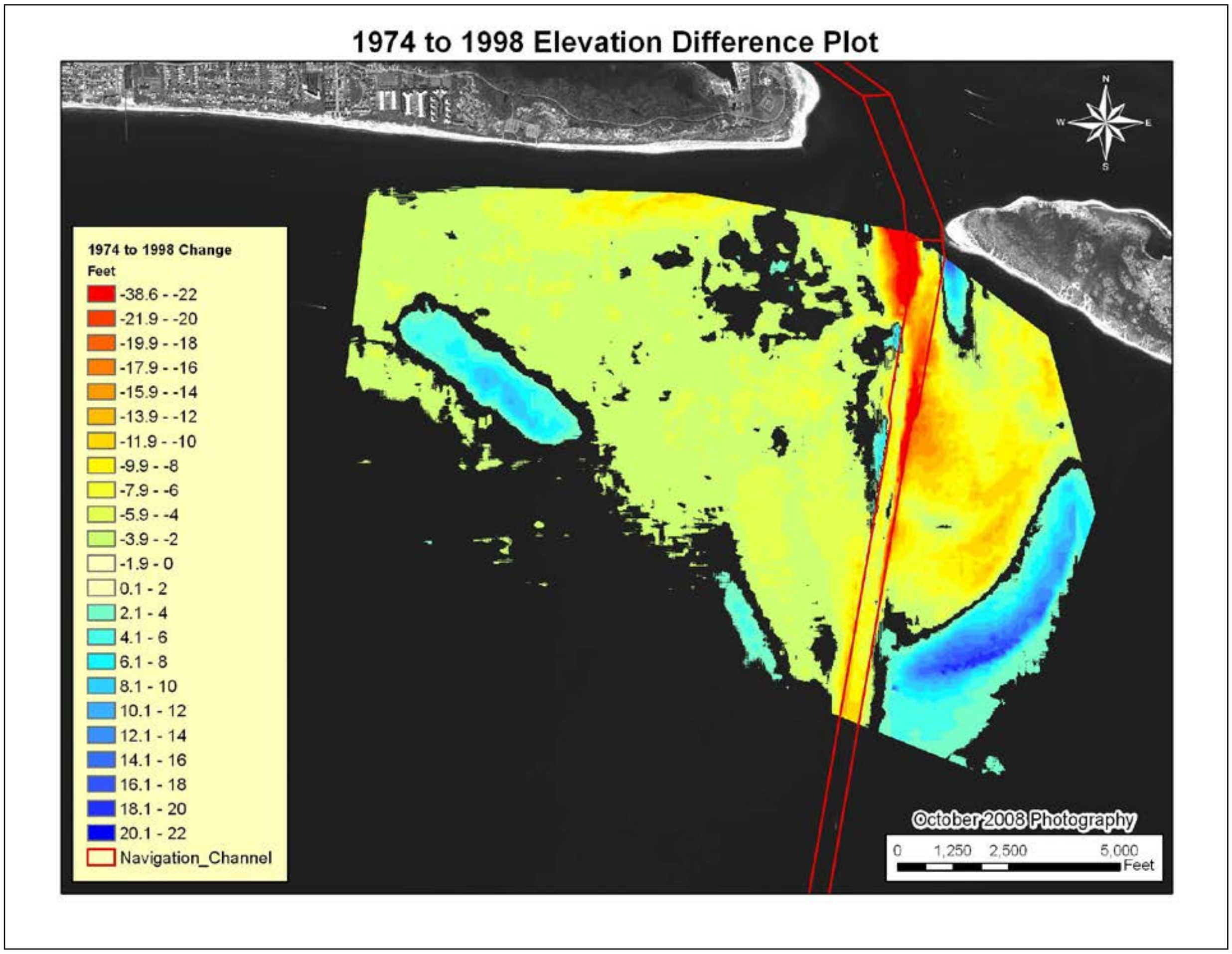


Figure 3-15. Bathymetric Changes, 1974 to 1998

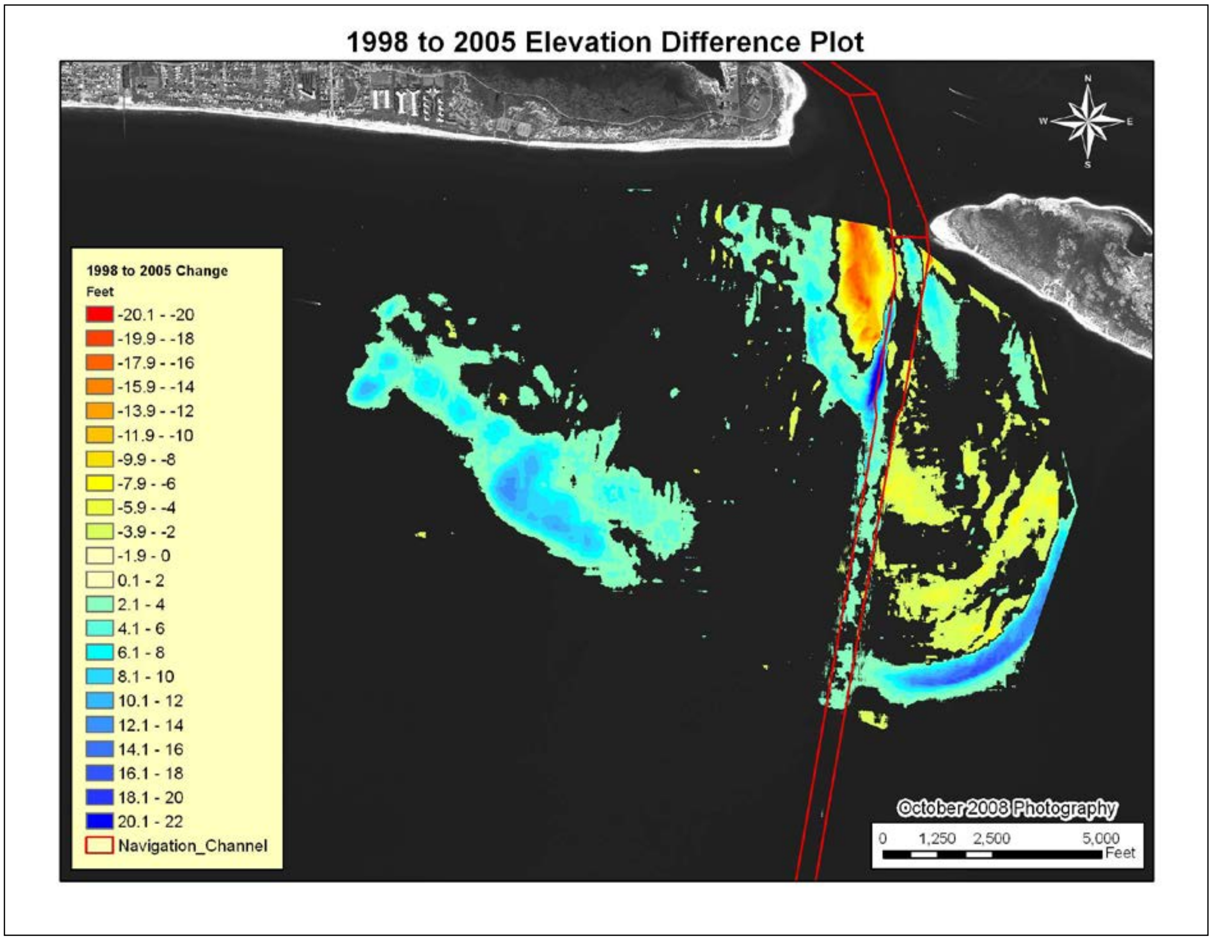


Figure 3-16. Bathymetric Changes, 1998 to 2005

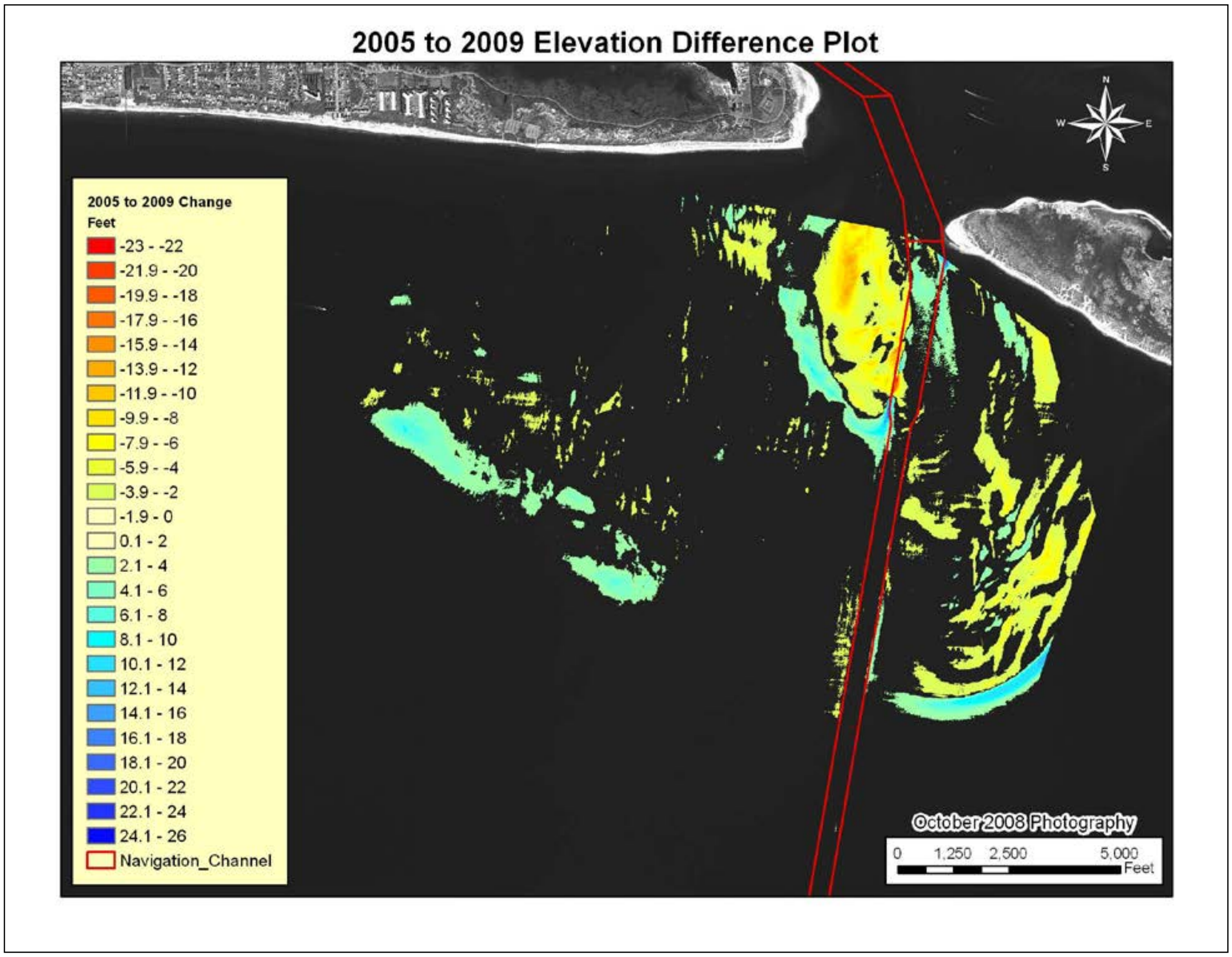


Figure 3-17. Bathymetric Changes, 2005 to 2009

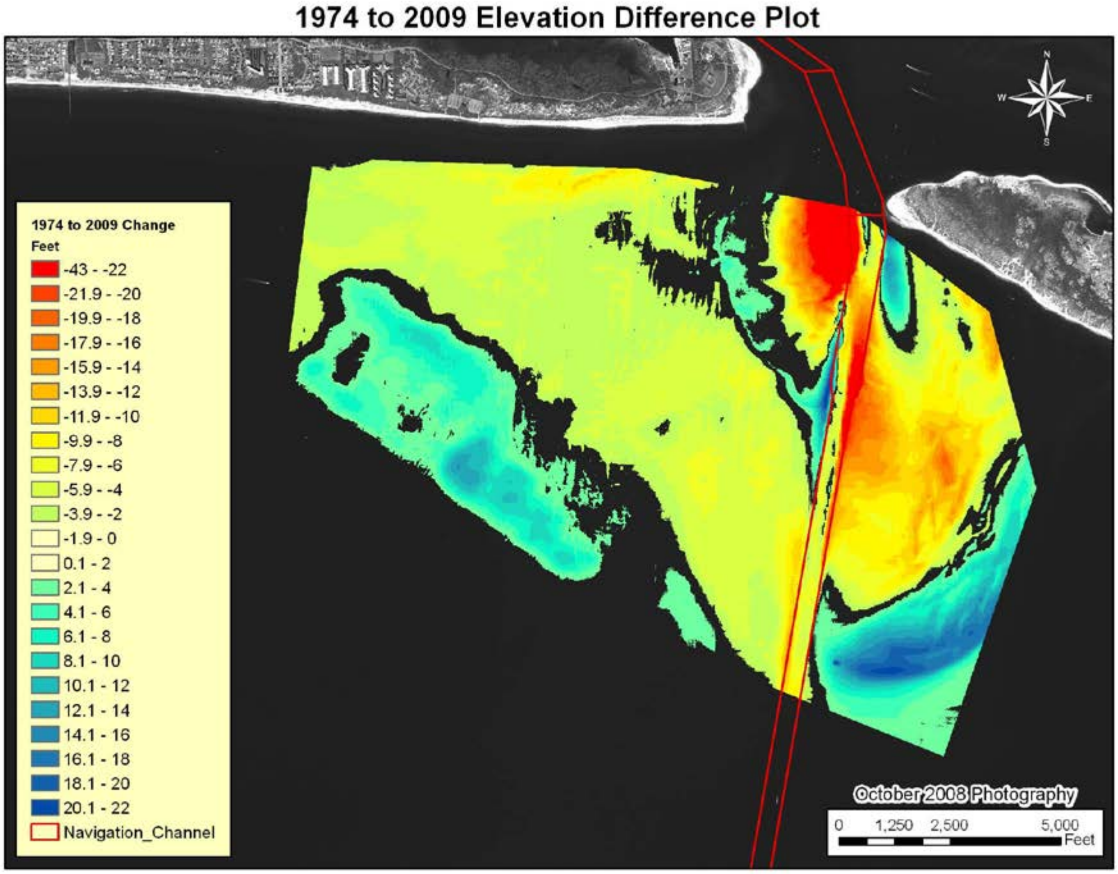


Figure 3-18. Bathymetric Changes, 1974 to 2009

<u>Volumetric Analysis.</u> In order to quantify the changes occurring within the inlet complex, a comparison of volumetric change over the different time periods of the available surveys was performed. The analysis included separating the inlet into six areas in an attempt to separate predominantly eroding and accreting areas as well as to isolate the anomalous areas discussed in the Bathymetric Change section of this report. Figures 3-19 through 3-24 show the six areas analyzed; volumetric changes are summarized in Table 3-4 and Table 3-5. The analysis was conducted over four time periods: from 1974 to 1998, 1998 to 2005, 2005 to 2009, and the cumulative period of 1974 to 2009. This was done to compute change rates over different time periods which could help determine if changes were increasing, decreasing, or relatively consistent within each region. Change rates for these periods are summarized in Table 3-6.

Figure 3-19 shows the analysis area for the east ebb tide delta located just off the point of the western end of Shackleford Banks. This area was mentioned earlier as having shown signs of accretion in an otherwise eroding portion of the ebb tide delta. Within the figure, the accreting area is clearly visible in blue surrounded by areas of erosion.

While this center section has been accreting, the area as a whole has eroded nearly 480,000 cubic yards since 1974, which translates to an average deflation of 2.9 feet for this area over the period of analysis. Looking further into the different time periods analyzed shows that the majority of change within this region occurred in the first time period, 1974 to 1998, while the two subsequent time periods showed accretion in the area as a whole. The change rate for this region over the entire analysis period of 35 years was approximately -13,700 cubic yards per year.

Figure 3-20 shows the middle section of the east ebb tide delta. This area has experienced considerable erosion when compared to the base year survey. Total erosion for the entire study period amounts to a loss of nearly 7,445,000 cubic yards of material. This loss of material results in an average deflation of nearly 9.2 feet over the entire area. Examining the different time periods shows that the erosion has been fairly consistent over all time periods, with the average loss rate being approximately 234,000 cubic yards per year from 1974 to 1998, approximately 146,000 cubic yards per year from 1998 to 2005, and nearly 202,000 cubic yards per year for the period 2005 to 2009. The overall erosion rate covering the entire time period is approximately 213,000 cubic yards per year.

The offshore portion of the east ebb tide delta is shown in Figure 3-21. Study of this area shows that it has accreted significantly since the 1974 survey, with a total increase of material being approximately 3,977,000 cubic yards. This amount of material averaged across the entire area shown in Figure 3-20 translates to an elevation increase of the seafloor of nearly 7.7 feet. As discussed earlier in this report, the changes appear to be related to the channel attempting to re-orient from a north-northeast configuration to more of a north-northwest orientation. This shift appears to be increasing current flow over the middle portion of the east ebb tide delta resulting in the losses shown in Figure 3-20. As this flow enters the offshore portion of the ebb tide delta, current velocities drop, resulting in a portion of the material lost from the middle section of the east ebb tide delta being deposited in the region covered by Figure 3-21. Examination of the first two time periods, 1974 to 1998 and 1998 to 2005, shows the accretion rate to be substantial in both; however, it appears to be decreasing in magnitude. The third time period from 2005 to 2009 indicates the area has begun to erode overall with an erosion rate of nearly 29,000 cubic yards per year over this time period. This is partly due to the continued migration of material into deeper areas offshore. These areas are outside of the survey coverage available and quantities for comparison are not available. The overall accretion rate for the region was approximately 114,000 cubic yards per year measured from 1974 to 2009.

Figure 3-22 displays the analysis area for the west ebb tide delta throat area. This area has experienced the most erosion relative to its size of any of the areas within the ebb tide delta. The area has eroded nearly 3,751,000 cubic yards since 1974 resulting in an average deflation of nearly 16 feet over the period of analysis. Review of the volumetric change rates for the 1974 to 1998, 1998 to 2005, and 2005 to 2009 time periods shows

the loss rate per year increasing with time. The average loss rate for the region over the entire study period was found to be approximately 107,000 cubic yards per year. As discussed earlier in this report, the excessive loss rate in this area is more than likely due to material moving into the adjacent navigation channel which is dredged on a routine basis as part of the Morehead City Harbor navigation project.
The majority of the west ebb tide delta area is shown in Figure 3-23. This area has lost almost 7,877,000 cubic yards of material since the 1974 survey. This amount of material averaged over the represented area translates to an average deflation of nearly 3.4 feet over the period of analysis. Volumetric change rates have varied greatly over the different time periods within this area. This area lost approximately 322,500 cubic yards of material per year on average from 1974 to 1998. The following time period, 1998 to 2005, the area actually accreted nearly 173,200 cubic yards per year. This was most likely due to deposition of material within the nearshore area migrating into the west ebb tide delta, as well as material eroding from the western throat into the northeast corner of the ebb tide delta. The most recent period from 2005 to 2009 showed that the area again became erosive and lost material at an average rate of 323,800 cubic yards per year. The average loss rate per year over the study time frame of 1974 to 2009 was nearly 225,600 cubic yards per year.

The final area of the ebb tide delta included in our analysis was that of the Nearshore West Placement Area. Figure 3-24 shows the analysis area for this section of the report covering the nearshore placement area. A subsequent section of this report provides more in-depth analysis of the nearshore placement area confined only to the areas of placement and includes many more survey dates. The analysis in this section of the report is included only to provide a similar comparison of this area over the same survey dates used in the analysis of the remainder of the ebb tide delta. This analysis showed that the nearshore placement area represented in Figure 3-24 gained nearly 3,544,000 cubic yards of material since 1974, is an average gain of approximately 2.1 feet in seafloor elevation over the analysis area. This material gain is due primarily to the placement of beach quality material dredged from the Morehead City Harbor navigation channel. Analysis of the 1974 to 1998 survey comparisons showed the area to be eroding nearly 16,600 cubic yards per year while the 1998 to 2005 comparison showed the influence of the dredged material placement with the rate accreting at approximately 521,000 cubic yards per year. During the most recent time period, 2005 to 2009, the accretion rate slowed to just less than 99,000 cubic yards per year. Overall accretion rate for the entire study period is just over 101,000 cubic yards per year.

In conclusion, the ebb tide delta complex, as a whole, has experienced substantial erosion of approximately 12 million cubic yards since 1974. Without the quantities of material placed in the existing nearshore placement area (~6.2 million cubic yards), the total deflation would have been approximately 18.2 million cubic yards. This quantity is split between the two lobes of the ebb tide delta, with 78% lost from the west and 22% lost from the east lobe of the delta. The major exceptions to the general trend of deflation are in the offshore portion of the eastern ebb delta and the nearshore placement area on the western ebb delta for the reasons detailed earlier in this section. An understanding of coastal inlet processes suggests that continued erosion of the ebb tide delta complex is likely to impact the adjacent beaches. The mechanisms of ebb tide delta deflation that would lead to impacts to the adjacent beaches include: (1) increased wave heights and changes to wave approach angles as a result of changes in the offshore wave transformation, which would result in increased shoreline erosion and volumetric losses of sand along the beach; (2) expected changes in longshore transport rates and flow paths of sediment; and (3) expected changes in the shoaling rates within the channel. The locations, severity and timing of the impact are unknown at this time. It is likely that any impact to the shoreline along Bogue Banks up to this point has been offset by previous placement of Federal navigation maintenance material along the eastern end of the island as indicated in the Section 111 report; however, continued deflation of the ebb tide delta, particularly if the delta is not supplemented with nearshore placement, could eventually overtake those efforts.

Practical and sound efforts will be considered to retain littoral material dredged from the navigation channels within the inlet complex to minimize this ebb tide delta deflation. While the USACE will continue to minimize disposal of coarse-grained material in the ODMDS as much as possible, the narrow dredging window that we have attempted to work within (usually 90 days between January-March) often requires that dredge vessels work in adverse weather and seas. As a result, disposal of some material in the ODMDS is required in order to accomplish all dredging work within the short timeframes associated with those windows. On past contracts, when weather conditions were deemed unsafe for placement of material in the Nearshore West Placement Area, contractors were allowed to dispose of material in the ODMDS. Based on analysis of dredging operations between years 1995 and 2006, approximately 43% of coarse-grained material that was intended for the nearshore placement area was diverted to the ODMDS due to weather restrictions. No practicable alternatives exist to the occasional placement of material in the ODMDS when hopper dredges are the necessary piece of dredging equipment, as further described below.

The USACE is committed to reducing the impact that its dredging program has on endangered sea turtle species. Hopper dredging, in particular, can pose dangers to turtles in the water, and USACE has elected over the past 15 years, with the concurrence of all resource agencies, to voluntarily restrict its hopper dredging at MHC to the winter months of January-March, when likelihood of turtle encounters is at its lowest. Dredging is most difficult to accomplish in wintertime months, due to the increased frequency and duration of foul weather. Foul weather conditions, especially those which result in increased wave amplitude, make placement of material in the Nearshore Area hazardous for a laden dredge, which often has minimal clearance when placing material in the nearshore. The USACE has chosen to allow its contractors to continue to dredge in foul weather, allowing them to dispose in the ODMDS when weather and wave conditions make nearshore placement hazardous. To do otherwise, and require contractors to stop work in high wave conditions, would have two distinct consequences: costs for dredging would increase, and just as importantly, it would be far less likely that the USACE could accomplish the work within the narrow 90-day environmental window. This would mean that the USACE, in addition to paying more for the job, would face the choice of not being able to finish the navigation dredging or, alternatively, increase its risk of killing federally-listed threatened and endangered turtles. The Wilmington District is currently assessing the risk of expanding its hopper dredging window, and will coordinate such expansion with appropriate agencies should it prove warranted.

In the FY 2013 dredging season, the USACE confirmed the impracticability of a “No ODMDS” policy. In the contract solicitation advertised in late 2012, the USACE removed the ODMDS foul-weather option from the proposed contract, leaving the Nearshore West Placement Area as the only available placement option. Only one dredging company responded to the solicitation, and the prices offered by that company far exceeded the awardable range (the USACE is prohibited by law from entering into dredging contracts that exceed the Government estimate by more than 25%). The primary reason for the increased cost was the likelihood that the dredge would have to both attempt nearshore placement in foul weather (risking damage to vessel and danger to crew) and shut down more often when weather was deteriorating. Experience has shown that utilizing a hopper dredge to dispose of material on the beach also necessitates some disposal of material in the ODMDS during adverse weather conditions, as the pump-out of hoppers can be difficult in foul weather. The only practicable alternative available to the USACE, when utilizing hopper dredges, is to allow the disposal of material into the ODMDS in hazardous conditions.

The USACE has continued to explore options that reduce the amount of beach-quality material placed in the ODMDS, without removing from a vessel captain the essential flexibility necessary to protect vessel and crew. Recent contracts for nearshore placement included language that limits the amount of dredged material that can be disposed of in the ODMDS. For each dump placed in the ODMDS, the contractor must document the weather and/or wave conditions that prohibited safe placement in the nearshore placement area. The USACE will continue to restrict the amount of beach-quality material disposed of in the ODMDS by using a variety of contract restrictions or incentives, as appropriate. Finally, it is important to note that the ODMDS has been, and continues to be, a valuable borrow source for material for use in storm damage reduction projects along all of Bogue Banks. The USACE specifically requires its contractors to place beach-quality material in specific sections of the ODMDS so that it can be available for future deposition on the beach. Recent locally-funded projects have used the ODMDS as a borrow site, and both Carteret County and the USACE have included the ODMDS as a preferred borrow site for material in their long-term storm damage reduction plans. It is the USACE’s expectation that future trends will mirror the past decade, where more material was removed from the ODMDS than was placed into it. While disposal of coarse-grained material in the ODMDS is never the USACE’s preferred option, the ODMDS remains a valuable “safety net” for this project, allowing for winter dredging of the channel in an environmentally responsible manner, while preserving the coarse-grained material for future use.

A comprehensive monitoring program, as outlined in Appendix F (Morehead City Harbor Monitoring Plan), will provide data to assess ongoing operations and impacts.

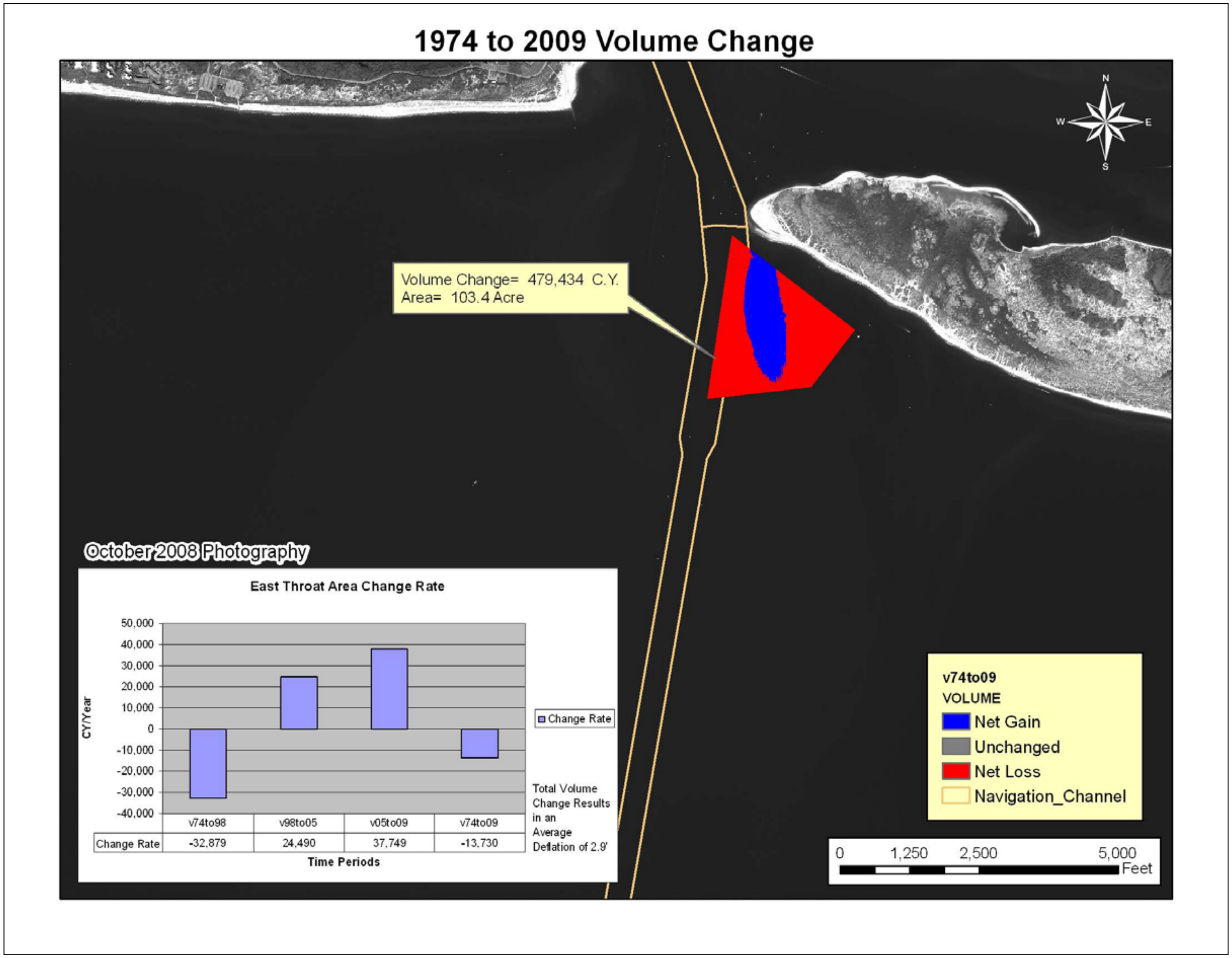


Figure 3-19. East Throat Area Volumetric Change

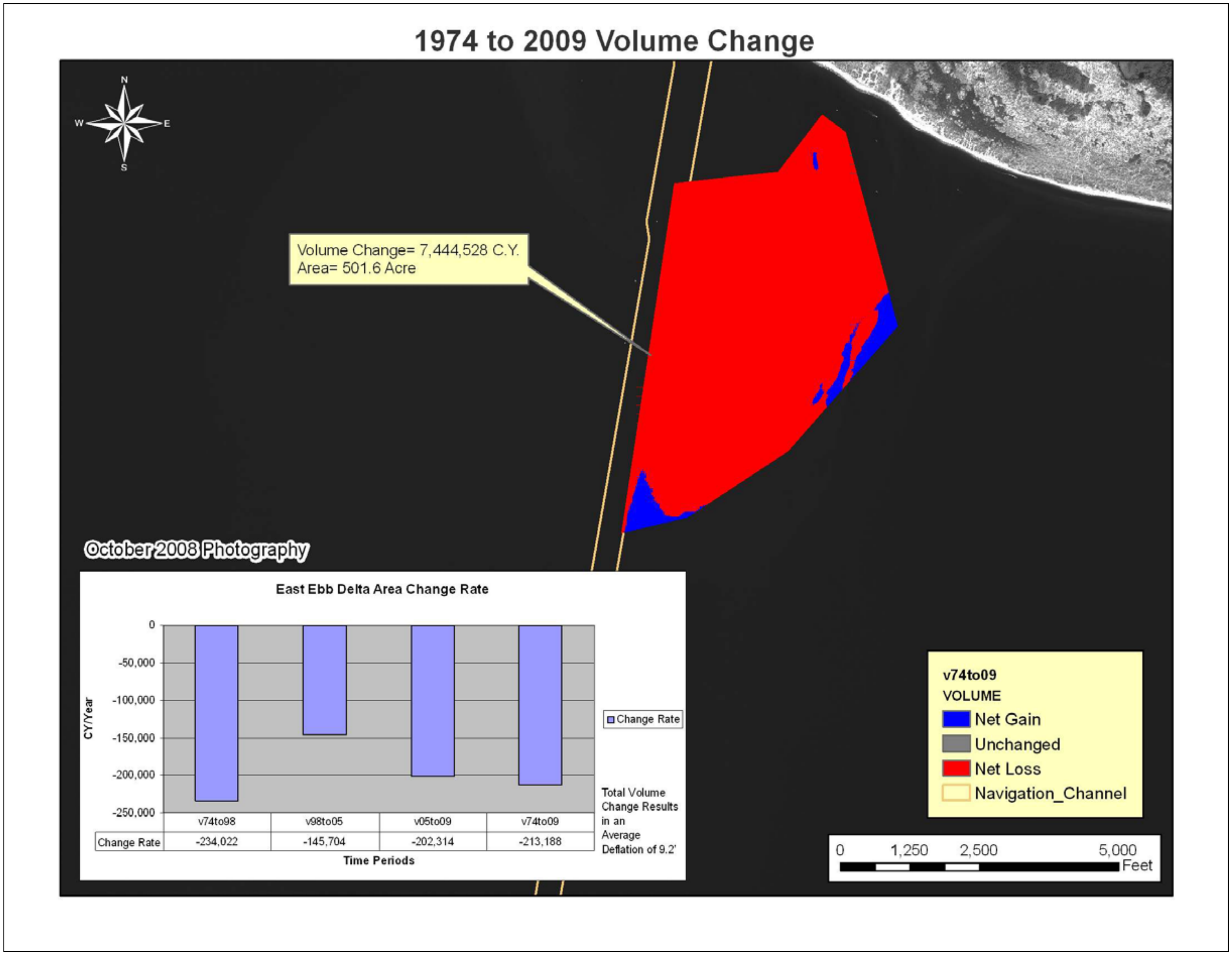


Figure 3-20. East Ebb Delta Volumetric Change

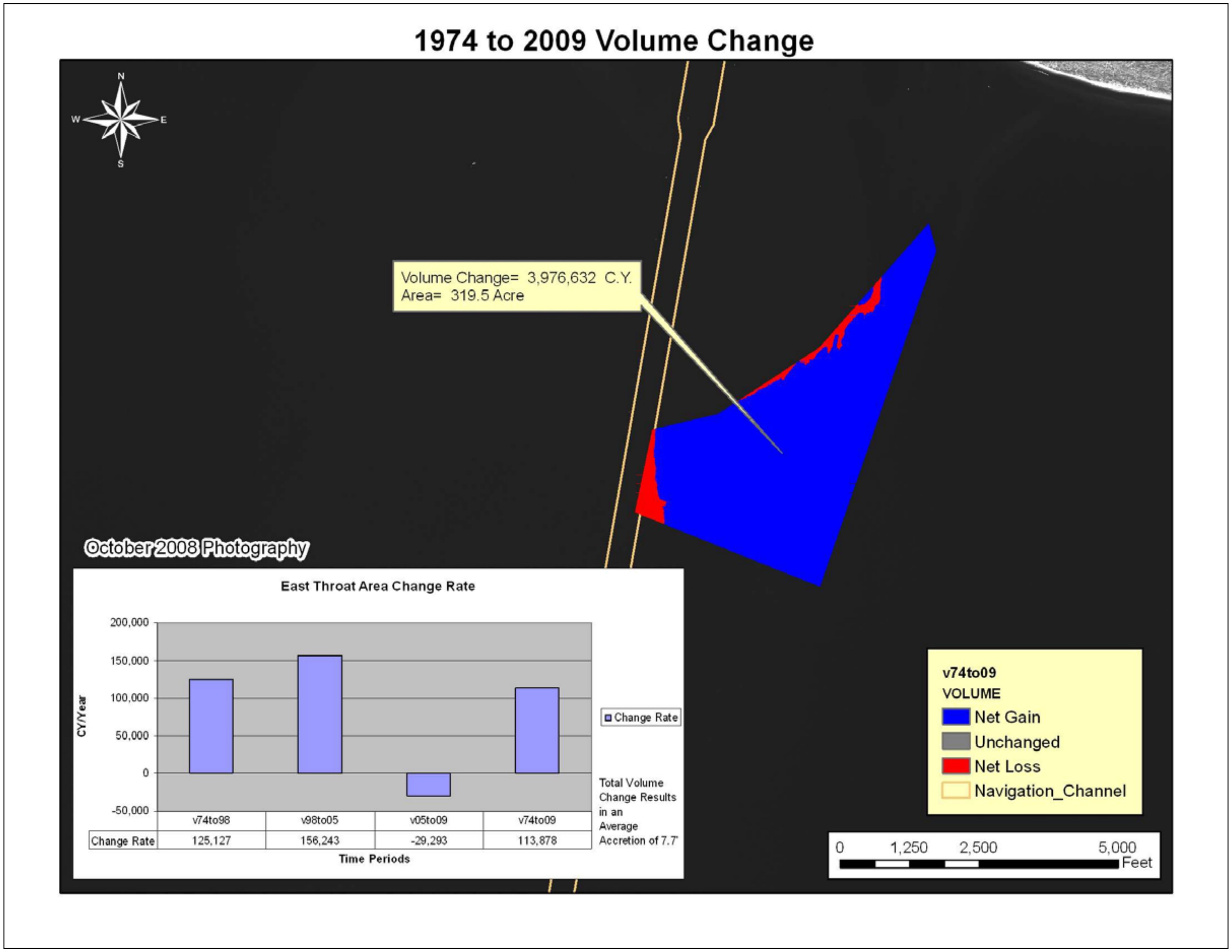


Figure 3-21. East Offshore Delta Area Volumetric Change

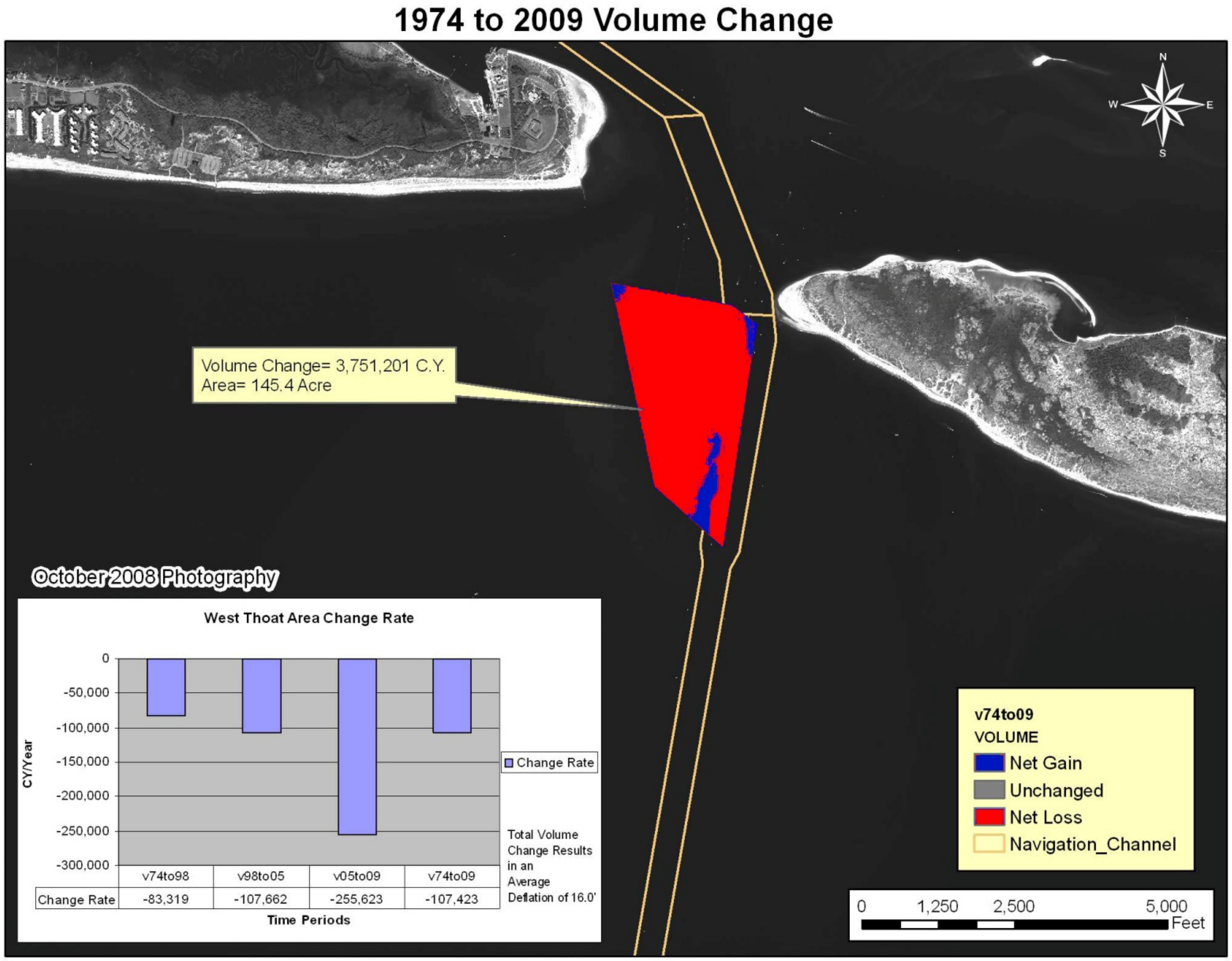


Figure 3-22. West Throat Area Volumetric Change

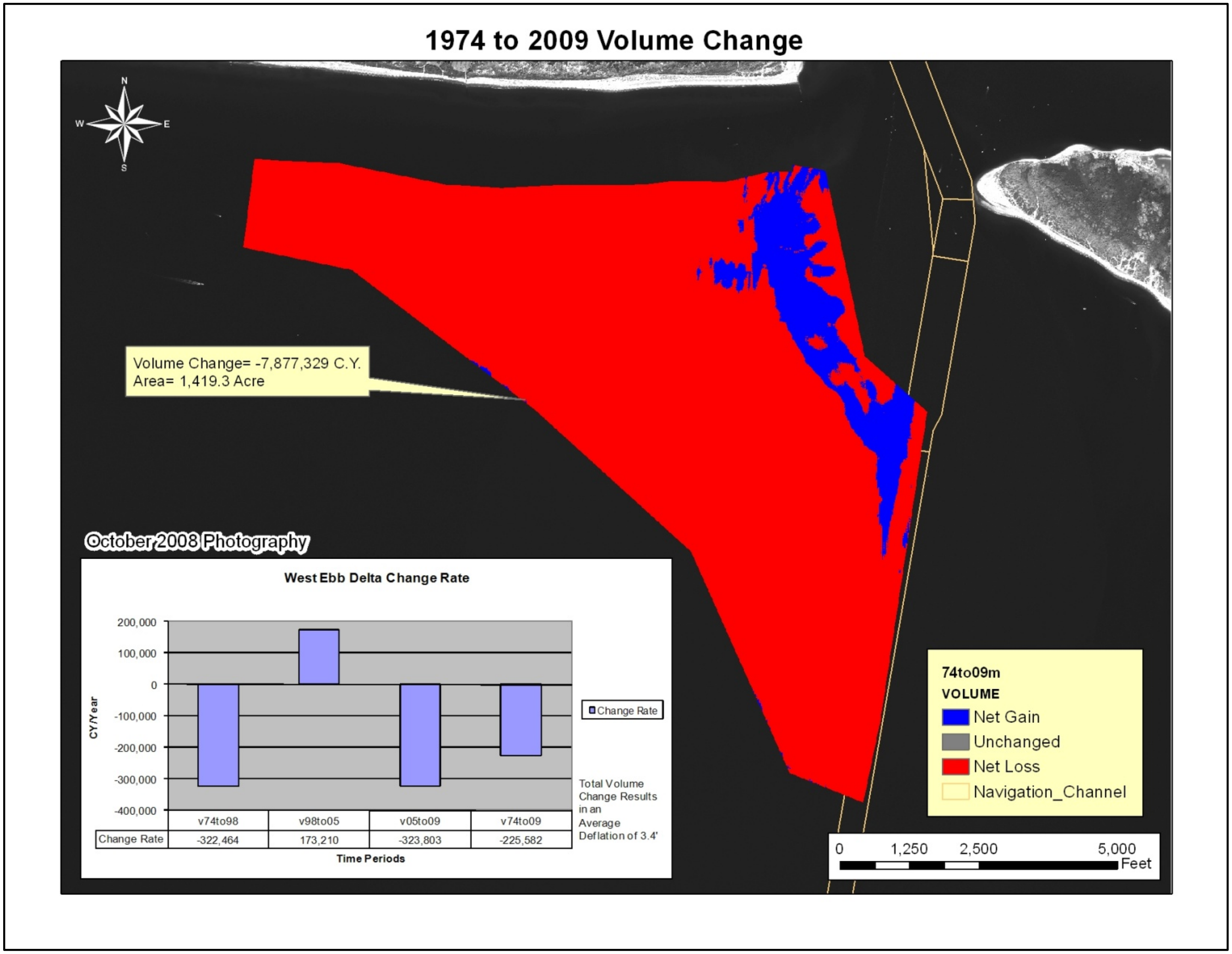


Figure 3-23. West Ebb Delta Volumetric Change

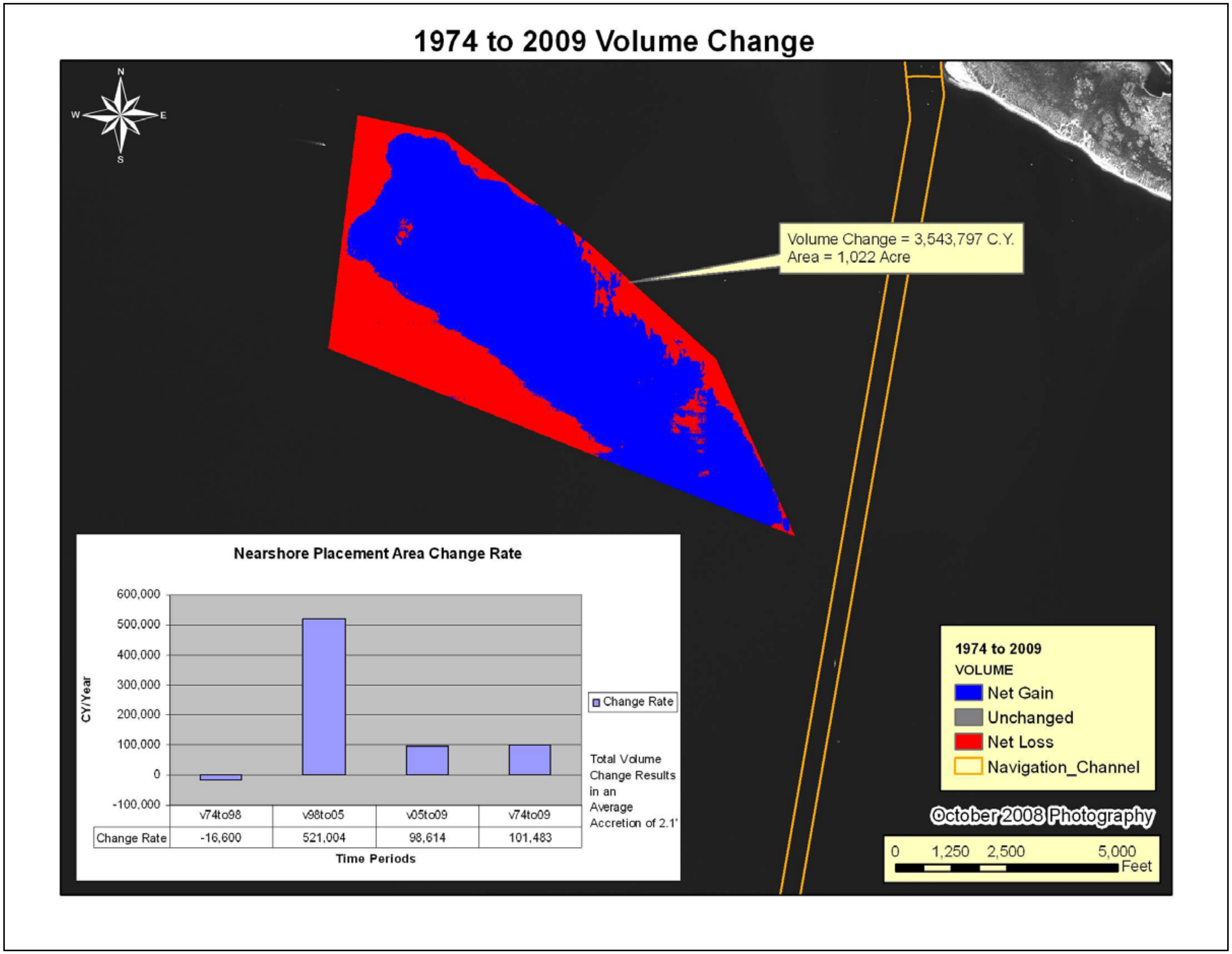


Figure 3-24. Nearshore Placement Area Volumetric Change

Location	Area (Square Feet)	Volume Change 1974-2009 (Cubic Yards)	Average Vertical Change (Feet)
East Throat Area	4,502,995	-479,434	-2.9
East Ebb Delta	21,848,459	-7,444,528	-9.2
East Offshore Delta	13,916,629	3,976,632	7.7
West Throat Area	6,334,870	-3,751,201	-16.0
West Ebb Delta	61,824,956	-7,877,329	-3.4
Nearshore Disposal Area	44,529,776	3,543,797	2.1
Total	152,957,683	-12,032,063	

Table 3-4. Volumetric Change and Vertical Shift

Location	Volume Change 1974-1998 (Cubic Yards)	Volume Change 1998-2005 (Cubic Yards)	Volume Change 2005-2009 (Cubic Yards)	Volume Change 1974-2009 (Cubic Yards)
East Throat Area	-794,678	167,269	147,975	-479,434
East Ebb Delta	-5,656,301	-995,155	-793,071	-7,444,528
East Offshore Delta	3,024,319	1,067,141	-114,829	3,976,632
West Throat Area	-2,013,831	-735,329	-1,002,041	-3,751,201
West Ebb Delta	-7,793,949	1,183,024	-1,269,308	-7,877,329
Nearshore Disposal Area	-401,227	3,558,459	386,566	3,543,797
Total	-13,635,667	4,245,409	-2,644,709	-12,032,063

Table 3-5. Volumetric Change Summary

Location	Volumetric Change Rate 1974-1998 (Cubic Yards/Year)	Volumetric Change Rate 1998-2005 (Cubic Yards/Year)	Volumetric Change Rate 2005-2009 (Cubic Yards/Year)	Volumetric Change Rate 1974-2009 (Cubic Yards/Year)
East Throat Area	-32,879	24,490	37,749	-13,730
East Ebb Delta	-234,022	-145,704	-202,314	-213,188
East Offshore Delta	125,127	156,243	-29,293	113,878
West Throat Area	-83,319	-107,662	-255,623	-107,423
West Ebb Delta	-322,464	173,210	-323,803	-225,582
Nearshore Disposal Area	-16,600	521,004	98,614	101,483

Table 3-6. Volumetric Change Rate Summary

3.2.4.2 Ebb Tide Delta Placement

In an effort to retain the material dredged from the navigation channel within the littoral system, a nearshore placement area was established in 1995 on the west side of the navigation channel within the Beaufort Inlet ebb shoal (Nearshore West). The existing nearshore placement area is shown in Figure 3-25 and is located approximately between 0.65 and 2.0 miles from the shoreline of Fort Macon State Park centered on the 25-foot mean low water (mlw) contour. The currently-authorized nearshore placement area covers approximately 559 acres of sea floor and the area is currently functioning as a placement location for coarse-grained sand exclusively (sand content greater than or equal to 90%). This DMMP proposes to only place coarse-grained sand (sand content greater than or equal to 90%) in the nearshore placement areas.

Dredging records indicate a total of nearly 6,200,000 cubic yards of material were placed within the Nearshore West Placement Area between 1995 and 2006 (Table 3-7). Average placement into the nearshore placement area is approximately 550,000 cubic yards per year for the referenced time period. This annual quantity placed within the nearshore environment exceeds the rate loss of the ebb tide delta as discussed earlier in this report. When the 6.2 million cubic yards placed into the nearshore areas of the west ebb tide delta since 1974 is factored into the losses in Table 3-6 (Volumetric Change Rate Summary), it is shown that this area lost nearly 14,266,000 cubic yards, or 408,500 cubic yards per year through 2009. Including the 6.2 million yards of material placed into the deflation calculation is conservative in that the placed material may have eroded at a faster rate than the natural delta. However, given the limited number of surveys of the ebb tide delta, it is not possible to accurately segregate this material and independently measure its influence on the deflation rate. Continued placement of dredged material within the western nearshore environment should reduce or ameliorate the overall deflation impacts related to the dredging of the navigation channel. However, deflation rates of the ebb delta will vary annually based in part on the amount of material disposed of offshore due to weather conditions during dredging events.

Analysis of bathymetric surveys indicates that material placed within the existing nearshore area is being retained within the littoral system, and portions of the material are moving landward, reducing the rate of deflation of the western lobe of the ebb tide delta. The analysis of the nearshore zone surveys also indicates that material placed in smaller lifts into shallower locations will diffuse more rapidly to the surrounding ebb tide delta. One isolated placement occurred in the vicinity of the Queen Anne’s Revenge Shipwreck (QAR) (Figure 3-25) in which nearly 41,000 cubic yards of material were placed with adequate pre- and post-construction surveys to monitor material evolution. Monitoring surveys of this area showed that the material diffused from the original location in a northeasterly direction and mound height decreased 6 feet over a period of 19 months. Based on these observations and in an effort to facilitate the diffusion of placed material toward the ebb tide delta, it is proposed that the existing Nearshore Placement Area be modified to extend farther landward, approximately to the -17 NAVD88 contour. Reasonable efforts, including potential use of light-loaded vessels, will be made to place nearshore material in depths less than -25 feet mlw (-27.3 NAVD) to facilitate diffusion and retain material within the littoral system. The one dredging method potentially best suited to material placement in depths of less than -25 feet mlw would be the use of a cutterhead pipeline dredge with direct pipeline placement in nearshore areas through use of a barge. This new method is recommended as a placement option in this DMMP. The -25 mlw depth contour suggestion is based on changes observed in the existing nearshore environment when comparing historic surveys of placement within the area, as well as an analysis of sediment movement within the nearshore environment contained in the 1992 USACE Design Memorandum and Environmental Assessment for Morehead City Harbor (USACE 1992). These comparisons showed that material placed in shallower depths up to -25 feet mlw diffused landward, nourishing the ebb tide delta. Material placed in depths beyond -25 feet mlw diffuses landward at a slower rate, except as driven by storms or other similar events. Material placed in deeper contours, however, could be beneficial to the ebb tide delta by stabilizing the offshore contours. In addition, the comparison of surveys showed no indication that material placed anywhere within the existing Nearshore Placement Area diffused offshore. These surveys indicate that this material has remained in the ebb tide delta system. Figure 3-25 displays the proposed expanded area for the existing nearshore placement area (Nearshore West). This proposed expansion covers 1,209 acres and expands the total placement area on the western side of the navigation channel to 1,768 acres total.

All material placed in the Nearshore West Placement Area is derived from maintenance of the Morehead City Harbor navigation project or adjacent navigation channels containing coarse-grained material. Amounts placed are dependent upon available funding and navigation priorities.

Figure 3-25. Existing and Expanded Nearshore West Placement Area

CALENDAR YEAR	NUMBER OF HOPPER LOADS (% OF TOTAL)					ESTIMATED VOLUME (CU YDS)*				
	ODMDS		NEARSHORE		TOTAL	ODMDS		NEARSHORE		TOTAL
1995	193	79%	51	21%	244	635,709	79%	172,472	21%	808,181
1996	0	0%	328	100%	328	0	0%	656,646	100%	656,646
1997	476	62%	296	38%	772	1,143,400	59%	781,700	41%	1,925,100
1998a	209	41%	295	59%	505	270,400	27%	725,600	73%	996,000
1998b	161	100%	0	0%	262	209,990	100%	0	0%	209,990
1999	391	65%	208	35%	599	759,330	64%	425,760	36%	1,185,090
2000	98	17%	475	83%	573	149,595	16%	786,115	84%	935,710
2001	259	100%	0	0%	259	718,655	100%	0	0%	718,655
2002	0	0%	175	100%	175	0	0%	560,313	100%	560,313
2003	111	25%	337	75%	448	282,994	25%	858,298	75%	1,141,292
2004	--	--	--	--	--	--	--	--	--	--
2005	24	23%	81	77%	105	63,236	22%	220,419	78%	283,655
2006	147	33%	305	67%	452	468,958	32%	993,926	68%	1,462,884
TOTAL	2069	44%	2551	54%	4722	4,702,267	43%	6,181,249	57%	10,883,516

Note: * Estimated volumes are derived from vessel dump records provided by dredging contractor for ocean placement verification.
They are not based on channel surveys or contract pay yardages.
Prior to 1999, the volumes were computed using an average load volume for the hopper rather than a reported specific load volume.

Table 3-7. Nearshore Placement Quantities – 1995-2006

The analysis of bathymetric surveys from 1974, 1998, 2005, and 2009 indicates that both the east and west lobes of the ebb tide delta at Beaufort Inlet have experienced substantial deflation. To date, material has been exclusively placed on the western lobe of the ebb tide delta to reduce delta deflation and retain material within the littoral flow. The results found earlier in the volumetric analysis section show that the eastern ebb tide delta has lost approximately 3,947,000 cubic yards of material. This is an average annual loss of approximately 113,000 cubic yards per year. In order to reduce further deflation of the eastern ebb tide delta, a new nearshore placement zone is proposed on the east side of Beaufort Inlet as part of this DMMP. The quantity of material to be placed in this new nearshore area over the three-year cycle of the proposed DMMP is expected to be the equivalent of the historic loss rate for the area over the three-year cycle, which is 339,000 cubic yards of sand (113,000 cy per year). This target quantity will be evaluated through the monitoring program and will be adjusted to conform to the evolving conditions of the east ebb tide delta. Additionally, quantities placed are subject to navigation priorities and the availability of dredging funds, which may not be sufficient to place quantities equivalent to the historic loss rate. Therefore, material placed within the ebb tide delta will be split between the western and eastern lobes based on the 78/22 ratio discussed earlier in this report within the Volumetric Analysis portion of the Ebb and Nearshore Shoal Analysis section. Over the life of this DMMP, it is the USACE’s intent to meet this 78/22 ratio, although individual dredging jobs will likely use a single nearshore area. Figure 3-26 displays the proposed location of the new placement area (Nearshore East), which is located approximately 0.25 miles seaward of the Shackleford Banks shoreline and outside the Cape Lookout National Seashore (CALO) boundary. The NPS CALO boundary ends at the mean low water contour along the Atlantic Ocean shoreline. The Nearshore East Placement Area covers approximately from the -17 ft NAVD88 contour to depths of -36 to -40 feet NAVD88 and is approximately 13,300 feet in length. In total, the proposed placement site covers an area of approximately 1.29 square nautical miles (1,094 acres).

The new proposed region for this nearshore placement area is entirely within the westerly transport region of Shackleford Banks as established in the USACE Section 111 report (USACE 2001). The net flow within this region of Shackleford Banks is westerly, toward the Inlet. Material placed within this area should move toward the west and nourish the eastern side of the ebb tide delta. The NPS supports placement of sediment in the Nearshore East (Appendix D, NPS letter dated 11 June 2014).

As shown in Figure 3-27, dredged material that may be placed within the Nearshore West and East will come from the main navigation channel reaches that contain sediments that are used for beach disposal in year 1 of the 3-year Harbor maintenance cycle. Material dredged from this section in years where there is no beach disposal operation has typically been placed in the nearshore placement area or in the ODMDS during adverse weather conditions. The inclusion of material from this section of the channel into the newly proposed Nearshore East should reduce future deflation of the eastern lobe of the ebb tide delta. In addition, providing additional placement areas within the littoral zone may reduce weather related disposal of the dredged material in the ODMDS which would reduce future ebb tide delta deflation. In particular, the existing nearshore placement area has filled to the point that hopper dredges can no longer feasibly operate in that area. While the expanded Nearshore West should open up some limited areas for hopper dredge placement, the Nearshore East is likely to be the preferred location for hopper placement. Conversely, the Nearshore West will be the preferred location for direct-pipeline placement using barges.

Quantities of material dredged in non-beach disposal years that exceed the annual losses to the ebb tide delta may be available for beach placement by a local entity. Any requests by local entities to place this excess dredged material on adjacent beaches would be evaluated on a case-by-case basis and would be funded by the requesting entity. The excess material would be required to remain within the Beaufort Inlet system, and as such would only be available for placement within the limits described in Section 3.2.2, Beach Placement. Placement of dredged material from the Beaufort Inlet complex west of station 59 on Bogue Banks (Figure 3-12 Proposed Bogue Banks Placement Area) would remove material from the complex and potentially increase delta deflation and for this reason would not be acceptable.

In order to monitor the evolution of the ebb tide delta and verify anticipated migration of material from the nearshore placement areas to the surrounding ebb tide delta, an extensive monitoring program has been developed and is included as Appendix F (Morehead City Harbor Monitoring Plan). Monitoring is proposed to include semiannual beach profile survey collection, pre- and post-placement surveys of the placement sites within the nearshore placement areas, including a 1000’ buffer around such sites, annual aerial or satellite photography, and surveys of the ebb tide delta lobes once every three years. These data will be evaluated annually and the results of the analyses will be considered in determining future disposal methodology. If monitoring indicates that the nearshore placement areas are becoming too shallow for dredges to access, those areas, pending coordination and environmental review, may be expanded to facilitate continued placement of material in the ebb tide delta.

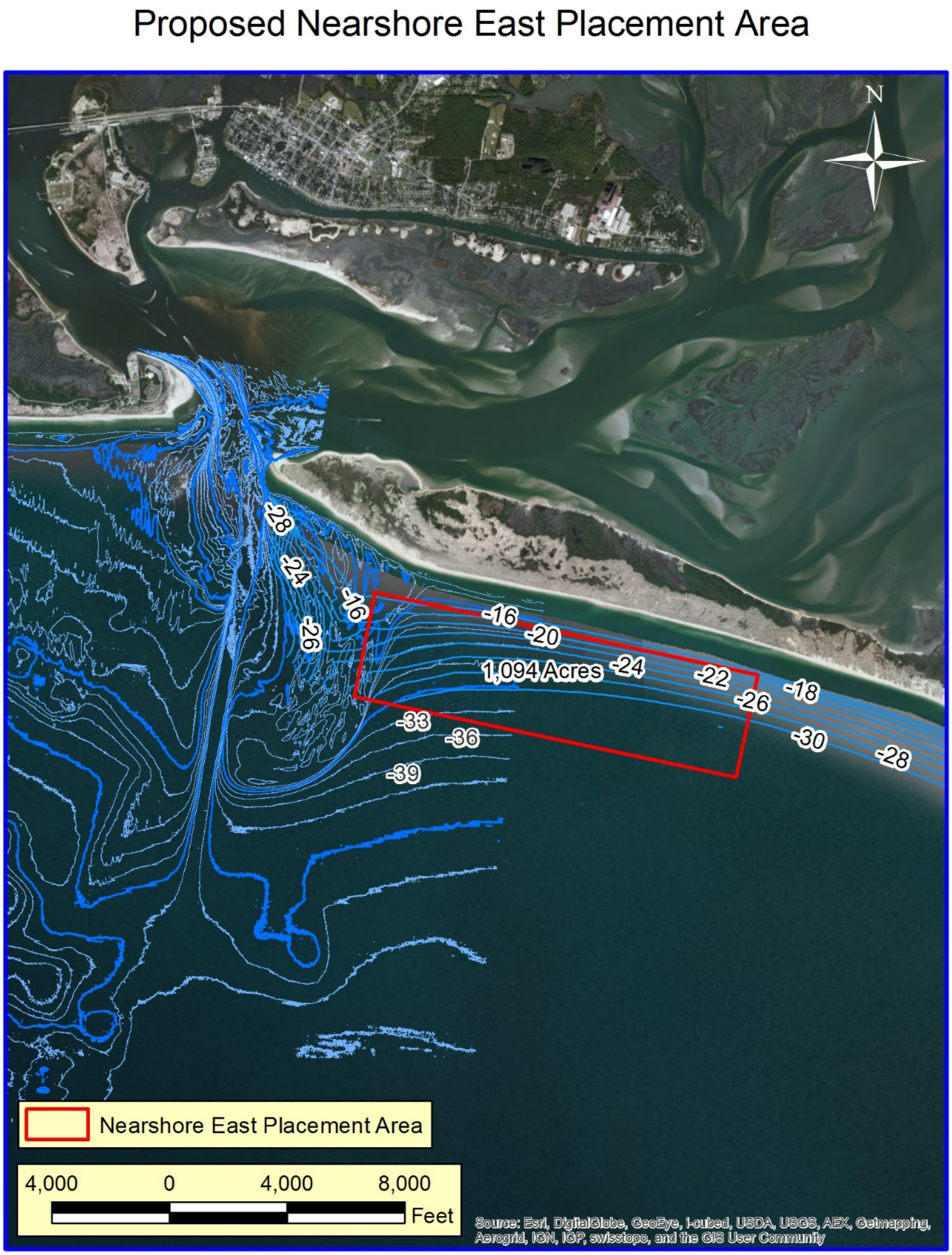


Figure 3-26. Proposed Nearshore East Placement Area

Figure 3-27. Inner/Outer Harbor Dredged Material Separation Based on Percent Sand

3.2.5 Modification of Environmental Windows

Environmental windows have been implemented to protect important resources from impacts due to dredging or disposal of dredged material. Resources of interest are sea turtles, shorebirds, colonial nesting waterbirds, juvenile fish and shrimp.

Current environmental windows for the Morehead City Harbor are based on dredging methods and the location of disposal. The following table outlines our current windows, and proposed changes to those windows. Further explanation of each is found below.

Dredging and/or Disposal Method	Current Window	Resource Protected	Source of Requirement	Proposed Window	Reason for Change
Hopper dredging	Jan 1-Mar 31	Sea turtles	Internal District protocol	Jan 1-Mar 31	No change proposed
Beach placement of dredged material	Nov 16-April 30	Sea turtles Nesting birds Fisheries	Endangered Species Act for turtles and plovers	Nov 16-Apr 30	No change proposed
Brandt Island disposal, if nesting birds are present	Sep 1-Mar 31	Nesting birds	Migratory Bird Treaty Act	Sep 1-Mar 31	No change proposed
Inner Harbor dredging with Brandt Island or ODMDS disposal, if no nesting birds are present	Aug 1-Mar 31	Fisheries	2009 IOP Consistency Concurrence from NCDCM, NC Fisheries	Aug 1-Mar 31, for bucket & barge only, Northwest, West and East Legs	Impacts of suspended sediments on fisheries
Nearshore placement	Dec 1-Apr 30	Fisheries	1994 USACE FONSI for Nearshore Area	No window proposed	Need to place material in nearshore area in all seasons outweighs benefits of window

Table 3-8. Current Environmental Windows and Proposed Changes

- Hopper Dredging: The Wilmington District currently observes a January 1 through March 31 window. As further described in the DMMP, this window is not a required element of any known authorization, but has been the Wilmington District's internal practice to minimize dredging impacts on sea turtles. This hopper window is more stringent than the terms and conditions of the Regional Biological Opinion on hopper dredging by NOAA Fisheries, dated September 25, 1997 (NMFS 1997), which does not require a window for any hopper dredging in

North Carolina. If dredging must occur outside our informally-imposed window, the District will coordinate with appropriate State and federal resource agencies.

- Beach Placement of Dredged Material: Wilmington District's Endangered Species Act coordination for nesting sea turtles includes a window of November16 – April 30 to avoid impacts to nesting turtles. The District does not plan to change this window. On occasion, when a dredging job has been delayed, the window is extended after coordination with U.S. Fish and Wildlife Service (USFWS) and State agencies, with additional monitoring requirements imposed to protect nesting turtles. After March 31, nesting shorebirds are also a concern, and dredging could be halted or moved to avoid impacts to shorebirds, as necessary.

- Brandt Island Disposal, if nesting birds are present: If nesting birds are present on Brandt Island, Wilmington District observes a window of September 1 – March 31 to avoid impacts. If no birds are present, no window is in place. The District does not plan to change this window.

- Inner Harbor Dredging with Brandt Island or ODMDS Disposal, if no nesting birds are present: By letter of March 18, 2009, the NC Division of Marine Fisheries wrote a two-sentence letter recommending a dredging moratorium from April 1 through July 31 in the MHC Inner Harbor. No explanation was given for the window, which was subsequently incorporated into the NC Division of Coastal Management CZMA Consistency concurrence for the Interim Operations Plan. By letter of February 18, 2014, the National Marine Fisheries Service recommended that the existing Inner Harbor (Northwest, West and East Legs) window of Aug 1-March 31 remain in place, for bucket and barge dredging only, due to the potential impacts to larval fishes as a result of increased suspended sediments. The Wilmington District plans to adhere to the existing window with regard to bucket and barge dredging, but has no data to suggest such a window is necessary for pipeline dredging, therefore no window for pipeline dredging in the Inner Harbor is proposed.

- Nearshore Placement: In establishing the nearshore placement area in 1994, the Wilmington District proposed a window for placement in the nearshore area of December 1 – April 30. The reason for the window appears to be concern about interference of material placement with the mullet seine fishery. This fishery is no longer active in MHC, and the District proposes no window on placement in the nearshore placement areas.

The environmental windows currently in place have been coordinated with State and federal regulatory agencies, and most windows are protective of resources of concern. Modification of environmental windows may seem reasonable; however, modification of some of the windows, could, in practice, cause adverse impacts to resources or the USACE's ability to maintain the project. One exception to modification of windows is that the USACE does not propose any seasonal restrictions on placement of material in the Nearshore West or Nearshore East, or on non-hopper dredging of the project (with disposal in Brandt Island, the ODMDS, or the nearshore placement areas, as appropriate). For non-hopper dredging activities and placement in nearshore and ODMDS locations, the marginal benefits associated with seasonal restrictions are not meaningful enough to justify the adverse effects of those restrictions on navigation safety, or to justify the additional costs associated with wintertime dredging. The USACE will continue to observe the seasonal dredging and placement restrictions listed above, and will coordinate with resource agencies if maintenance dredging is required outside current environmental windows.

With the exceptions noted above, current environmental windows are effective in protecting resources, and it is beyond the scope of this DMMP to address changes to the existing hopper dredging window. Should conditions change or new species of interest be identified, the environmental windows could be reevaluated during a regular reevaluation of the DMMP, or during appropriate coordination activities to address newly listed (threatened or endangered) species.

3.2.6 DMMP Measures Eliminated

Several measures considered and investigated for disposal/placement of maintenance dredged material for the Morehead City Harbor navigation project have been eliminated from further consideration for this DMMP and are described below. Although the measures described below have been eliminated from further consideration, for comparison purposes, several of them are included in the trade-off analysis in Section 3.4.1. Measures below that are beyond the scope, authority, or timeframe of the DMMP were not included in the trade-off analysis.

3.2.6.1 Brandt Island Dike Raises Along Existing Alignment

Description: If dredged material from the Inner Harbor continues to be disposed of in Brandt Island, capacity would be reached in 2028, well before the 20-year timeframe addressed by this DMMP. Measures that would prolong Brandt Island's longevity were investigated. Four potential dike heights were investigated to determine if it would be economical to raise the existing dike (37 feet NAVD88) at Brandt Island. Dike heights investigated included elevations of 42 feet NAVD88, along with elevations 47, 52, and 55 feet NAVD88. The amount of fill needed to construct these dike heights and the resultant storage capacities are shown below in Table 3-9. Note: the storage volumes below include the existing capacity of 3 million cubic yards.

Existing Dike Alignment		
Dike Height (elev)	**Dike Fill Volume (CY)**	**Total Storage Volume (CY) (assumes dike fill comes from interior of diked area)**
42’	62,000	3,482,000
47’	191,000	3,854,000
52’	398,000	4,142,000
55’	582,000	4,244,000

Table 3-9. Brandt Island Dike Raises Along the Existing Dike Alignment

Issues: Expansion with dike raises provides much more capacity for the money than dike raises along the existing alignment (Section 3.2.6.1). As an example, expanding the dike and raising it to a height of 52 feet provides 35% greater capacity for less cost per cubic yard than a dike height of 52 feet along the existing alignment. A cost summary for all dike heights considered is included in Section 3.3 (Costs of the Alternative Plans).

Conclusion: It is by far more feasible to expand and raise the dikes at Brandt Island than to raise them in place; therefore, raising the dikes along their current alignment was eliminated from further consideration.

3.2.6.2 Brandt Island Transfer of Material to the ODMDS

Description: Another measure considered to regain capacity at Brandt Island is a one-time pumpout with transfer of material to the ODMDS. This measure assumed the following:

- Access would be gained through the north dike wall adjacent to the spillway system.
- The access channel would be 100 feet wide and 20 feet deep with 3H:1V sideslopes.
- Approximately 100,000 cubic yards of material would have to be manipulated to open and close the dike.
- The interior pumpout would roughly follow the limits of the current ponded area down to elevation -20 feet msl.
- The existing quantity of material in the ponded area is 812,000 cubic yards (box cut with no sideslopes) plus the remaining capacity of Brandt Island, which is approximately 3,000,000 cubic yards. The total quantity of material to be

removed and hauled to the ODMDS would be approximately 3,812,000 cubic yards.

Issue: Based on a cost estimate prepared using the assumptions above, transfer of dredged material from Brandt Island to the ODMDS would cost approximately $37 million. If adequate funding was available to transfer the dredged material from Brandt Island to the ODMDS, then following clean-out of Brandt Island, dredged material disposal could resume in Brandt Island – the least cost option. However, it's unlikely that $37 million would ever be available to fund the clean-out, so once Brandt Island reaches capacity in 2028 the most feasible option is to dispose of the material in the ODMDS, which would cost an average of about an additional $1million a year from 2028 to 2034.

Conclusion: Once Brandt Island reaches capacity, based on current cost estimates, it is much more feasible to expand and raise the dikes at Brandt Island or to take maintenance dredged material from the Inner Harbor directly to the ODMDS rather than attempting to restore capacity in Brandt Island by transferring material from Brandt Island to the ODMDS. For this reason, the one-time pumpout of Brandt Island to restore capacity has been eliminated from further consideration in this DMMP.

<u>3.2.6.3 Recycle Material in Brandt Island through Hydrocyclone Density Separation</u>

Description: Another measure considered for managing Brandt Island and the mixed material within it is the use of Hydrocyclone Maximum Density Separators (MDS). A Hydrocyclone MDS is a relatively old technology that is used in the mining industry for aggregate separation, but its application in the dredging industry is relatively new. The driving force behind the technology is the principal of centrifugal force. A slurry mixture of water and silt/sand is pumped into the hydrocyclone system at relatively low pressure at an angle which results in a high angular velocity. This velocity forces coarse material toward the walls of the hydrocyclone while creating an area of low pressure in the center of the hydrocyclone. This low pressure vortex where the majority of liquid and fine material gathers is forced upward through the overflow outlet located on the top of the hydrocyclone. The coarser material continues down the walls of the hydrocyclone and exits through the bottom and is referred to as "underflow" (Figure 3-28).

The Brandt Island disposal facility has potential for deployment of this technology. The island contains large quantities of sand that are currently inaccessible through conventional dredging methods due to the mixing of sediments during previous island disposal operations. There are several potential benefits to sediment separation within the disposal island which include: 1) Beneficial use of extracted coarse-grained sand for beach disposal; 2) Nourishment of the deflated Beaufort Inlet ebb tide delta; 3) Use of overflow sediments for marsh creation; and 4) Reduction of the current volume within Brandt Island. This would reduce the future need for increases in the capacity of Brandt Island by either expanding and increasing the dike elevation or removal of material through hydraulic pumpout and disposal in the ODMDS.

Issues: 1) Several factors influence the efficiency and practicality of the use of this technology at Brandt Island. First, the hydrocyclone diameter and flow rate determine the grain size separation values and would be based on typical beach grain sizes (#200 sieve). To produce coarse-grained sandy material, a hydrocyclone of approximately 24-inch diameter would be required (Heibel 1995). Given the relatively small flow rate of the 24-inch hydrocyclone, approximately 2000 gallons per minute (gpm) with a 5:1 liquid/solid ratio, a bank of hydrocyclones would be required to operate simultaneously. Even with several hydrocyclones in operation continuously, the operation would take several months to complete. This duration would depend on the depth and width of material removed from Brandt Island, which has not yet been determined.

2) Material within Brandt Island would need to be handled multiple times during the separation process thus adding to the overall cost. The material would need to be screened to remove debris that would not be acceptable for beach disposal. This would require placement offshore or the establishment of a containment area for this unusable material. In addition, containment areas or disposal methods for the overflow material (finer than #200 sieve) would need to be created.

3) Since the hydrocyclone operation is in a fixed position, a method of removing the coarse-grained material produced would need to be developed. Unlike the overflow material which is pumped to a disposal area or barge, the underflow is relatively dry and would need to be moved by conveyor or mechanically loaded and trucked to a location where it could be hydraulically pumped at a later time. The isolated location of Brandt Island makes it difficult to mobilize necessary equipment and the lack of existing haul roads or staging areas makes a truck haul operation impractical at this time.

Conclusion: Given the lack of established methods for employing this method of sand separation and the lack of information related to the associated costs and durations, this measure is not considered a viable option for the Morehead City Harbor DMMP at this time and was eliminated from further consideration. As this technology develops and the need for additional space is required within Brandt Island, this option may be reevaluated.

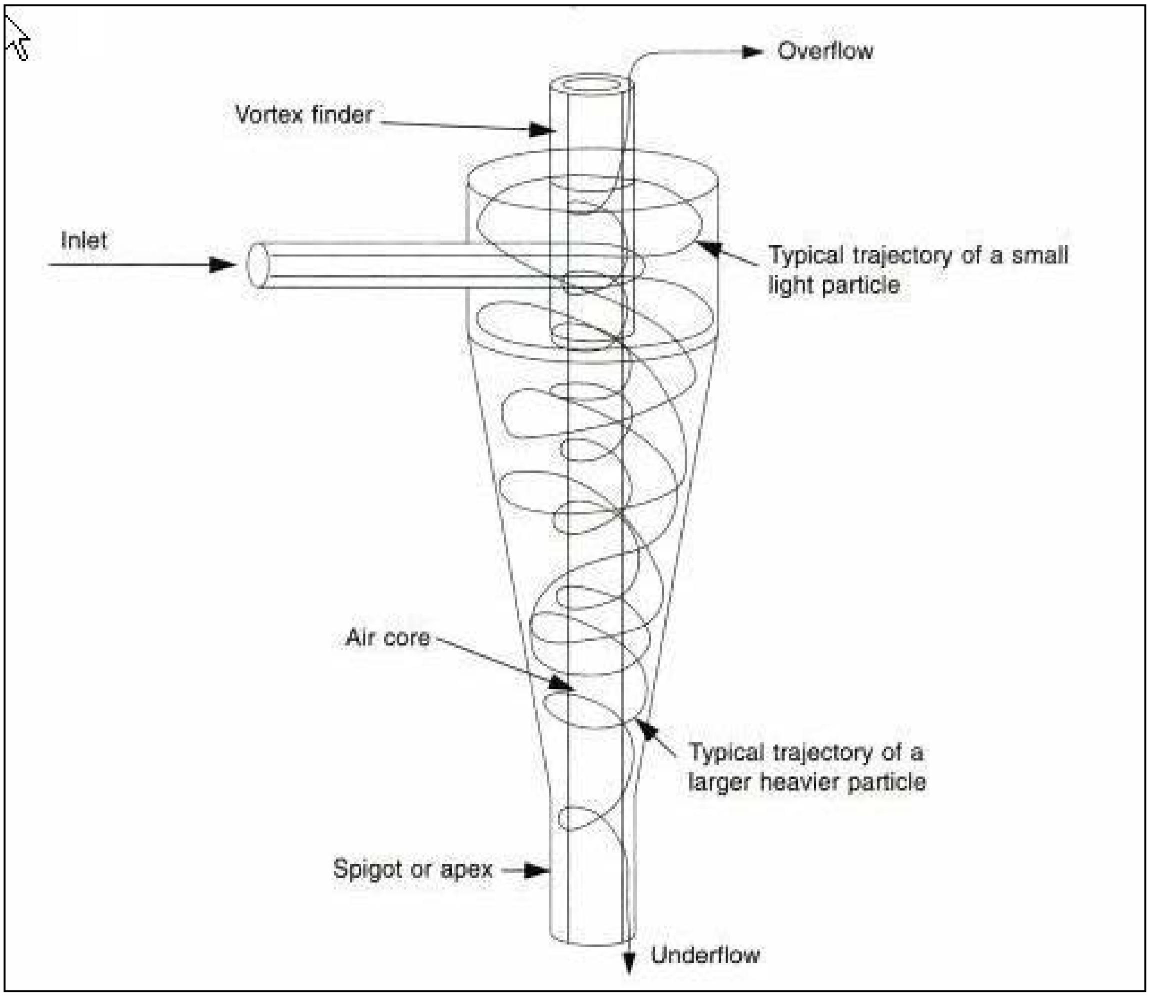


Figure 3-28. Typical Hydrocyclone Configuration

3.2.6.4 Continue to Use Existing Nearshore West Placement Area (Without Expansion)

Description: As previously discussed, one of the recommended disposal measures for the DMMP is shoreward expansion of the existing Nearshore Placement Area on the west side of Beaufort Inlet (3.2.4.2, Ebb Tide Delta Placement West of Beaufort Inlet). Another measure considered was the continued use of the existing Nearshore Placement Area without expansion.

Issue: It is possible to continue to use the existing Nearshore Placement Area for a limited amount of time without expansion, however, expansion provides two important benefits that would not otherwise be realized: 1) It facilitates the diffusion of placed material toward the ebb tide delta, and 2) increases site longevity.

Conclusion: Expanding the existing Nearshore Placement Area provides greater benefits than leaving it in its current configuration. The existing configuration has limited capacity, which would be increased by expansion. Also, expansion toward the shoreline would facilitate movement of placed material toward the ebb tide delta, which is important in ameliorating ebb tide delta sediment losses. Therefore, continued use of the existing Nearshore Placement Area without expansion, although a possibility, is not recommended as part of the base plan. It should be noted that cost was not an important factor in the evaluation of this measure as expansion of the Nearshore West costs only slightly more than continued use without expansion. The slightly higher cost is attributed to the additional area requiring coverage by the ongoing environmental surveys and future monitoring. However, the benefits of expansion offset these costs.

3.2.6.5 Creation of Colonial Nesting Waterbird Islands

Description: Quality nesting habitat for colonial waterbirds is a limited resource in North Carolina. A beneficial use of dredged material is placement of sand by control-of-effluent method to create and maintain islands at an early ecological successional stage for colonial nesting waterbirds. For this measure, the assumption was made that each island is circular and is about 15 acres in area, and 5 feet in elevation. Sand bags and/or geo-tubes would be placed along the circumference or perimeter of each island and then coarse-grained maintenance dredged material would be placed within the center of each island. This material would be excavated by pipeline dredge or hopper dredge from Outer Harbor ranges that contain coarse-grained material. Current water depths at the proposed bird island sites are about 5 feet.

Issues:

1) Essential Fish Habitat (EFH) – The areas of Bogue and Back Sounds that would be potentially suitable for island creation are designated as EFH. Construction of islands would involve conversion of approximately 15 acres of bottom habitat for each island constructed. Areas impacted would have to avoid EFH resources such as hard bottom and Submerged Aquatic Vegetation (SAV). Creation of one or more islands could potentially benefit SAV by creating

sheltered areas from high-energy wave and wind action thereby enhancing SAV habitat around the island. This effect has been seen around other control-of-effluent islands in North Carolina.

2) Suitable material requirements – Colonial nesting waterbirds prefer areas that are barren and consist of mainly coarse sand and small quantities of shell hash. As such, the North Carolina Wildlife Resources Commission recommends that material placed on these islands be greater than 90% sand (i.e., less than 10% fines).

3) Island size limitations – The size of the islands constructed and therefore the amount of material that could be placed on them would be limited. To prevent the establishment of mammalian predators on the islands, size must be limited to no more than approximately 15 acres. Height above the mean high water level is important because heights above 10 feet expose birds to higher winds and sand movement across the islands. The amount of material required to construct islands would be limited; for example, an island of approximately 15 acres and 5 feet high would require about 121,000 cubic yards. Two 15-acre islands would require approximately 242,000 cubic yards of coarse sand (i.e., greater than 90 % sand). This maintenance material would be excavated from the Outer Harbor by either pipeline dredge or hopper dredge, depending on the exact location of dredging. Dredged material from the Inner Harbor would be too fine to use for bird islands. Maintenance material from Range A is primarily dredged by hopper. Follow-up disposal of material would require less material depending on rates of erosion from the island.

4) Cost - Assuming a bird island would require approximately 121,000 cubic yards of material to construct, the cost for dredging and geotubes would be approximately $3.7 million per island or a cost of $7.4 million for both islands. This estimated cost does not include contingency, inflation, equipment costs (personnel, bulldozer on the island moving the end of pipeline or pushing sand, etc.), overfill factors, construction delays, etc.

Conclusion: The additional costs required to construct the islands are significantly greater than placing the material on nearby beaches or in the ebb tide delta (base plan), therefore the PDT recommends that the construction of the proposed Colonial Nesting Waterbird Islands be eliminated from further consideration for the Morehead City Harbor DMMP. However, this is a potential beneficial use of dredged material that could be pursued under separate federal authority – Section 204 of WRDA 1992, Beneficial Use of Dredged Material.

3.2.6.6 Dispose of Dredged Material on Radio Island

Description: Radio Island is located to the east of the existing Port of Morehead City, across the Intracoastal Waterway between the Port and Beaufort, NC (Figure 1-4 inset). Figure 3-29 is an aerial photograph of Radio Island showing its relationship to the existing Port, Morehead City, and Beaufort. The NCSPA owns approximately 250 acres on Radio Island. The southeastern portion of the island, known as East Beach, is currently designated a public access area and is used for recreational purposes. The northern end of the island (Radio Island disposal area), north of US 70, contains an active sand recycling site managed by the NCSPA, and the western shore of this area is a public access area owned by the Town of Morehead City. The southern tip of the island is owned by the US Navy and used for military deployment activities.

This measure considered disposal of coarse-grained dredged material in the existing Radio Island disposal site. Because the site is an active sand recycling site, the NCSPA only allows disposal of dredged material that contains greater than 80% sand. The site is approximately 32 acres in size and has a capacity of approximately 105,000 cubic yards. However, in June 2011, a six-slip public boat launch facility was constructed, thus reducing the overall size and capacity of the diked disposal area by approximately 25%. Therefore, the new diked area would be about 9.3 acres in size and its capacity would be about 79,000 cubic yards. Also, the NCSPA has a long-term plan (schedule undetermined) to expand, which could further impact the availability of Radio Island for future use.

Issue: The current capacity of the Radio Island disposal site would not accommodate the fine-grained material that would result from dredging of the Northwest and West Legs of the Inner Harbor.

Conclusion: The capacity of the Radio Island disposal site is too small to make this a feasible measure, therefore, disposing of dredged material on Radio Island was eliminated from further consideration.

Figure 3-29. Radio Island Disposal Area

3.2.6.7 Dispose of Dredged Material on Marsh Island

Description: Marsh Island is located north of the existing Port of Morehead City, across Calico Creek. The island is an inactive dredged material disposal site, approximately 58 acres in size (Figure 3-30). The capacity of the existing diked area at Marsh Island is so small that this option considered expanding the existing dike and possibly increasing the dike elevation as needed to accommodate more dredged material. This measure did not consider dike expansion into wetland areas as mitigation costs would render this measure too costly to implement.

Issue: The existing diked disposal area is about 9 acres in size and its dredged material capacity is approximately 7,500 cubic yards. The existing dike height is 14.5 feet NAVD88. Even if the dike could be expanded to encompass non-wetland areas it would only provide about 128,000 cubic yards of dredged material capacity which is less than required for one dredging event. This capacity estimate assumed the dike would not be raised, but would remain at its current height of 14.5 feet NAVD88.

Conclusion: Marsh Island is so small that it does not provide adequate capacity to be considered a viable measure. For this reason, disposing of dredged material on Marsh Island was eliminated from further consideration.

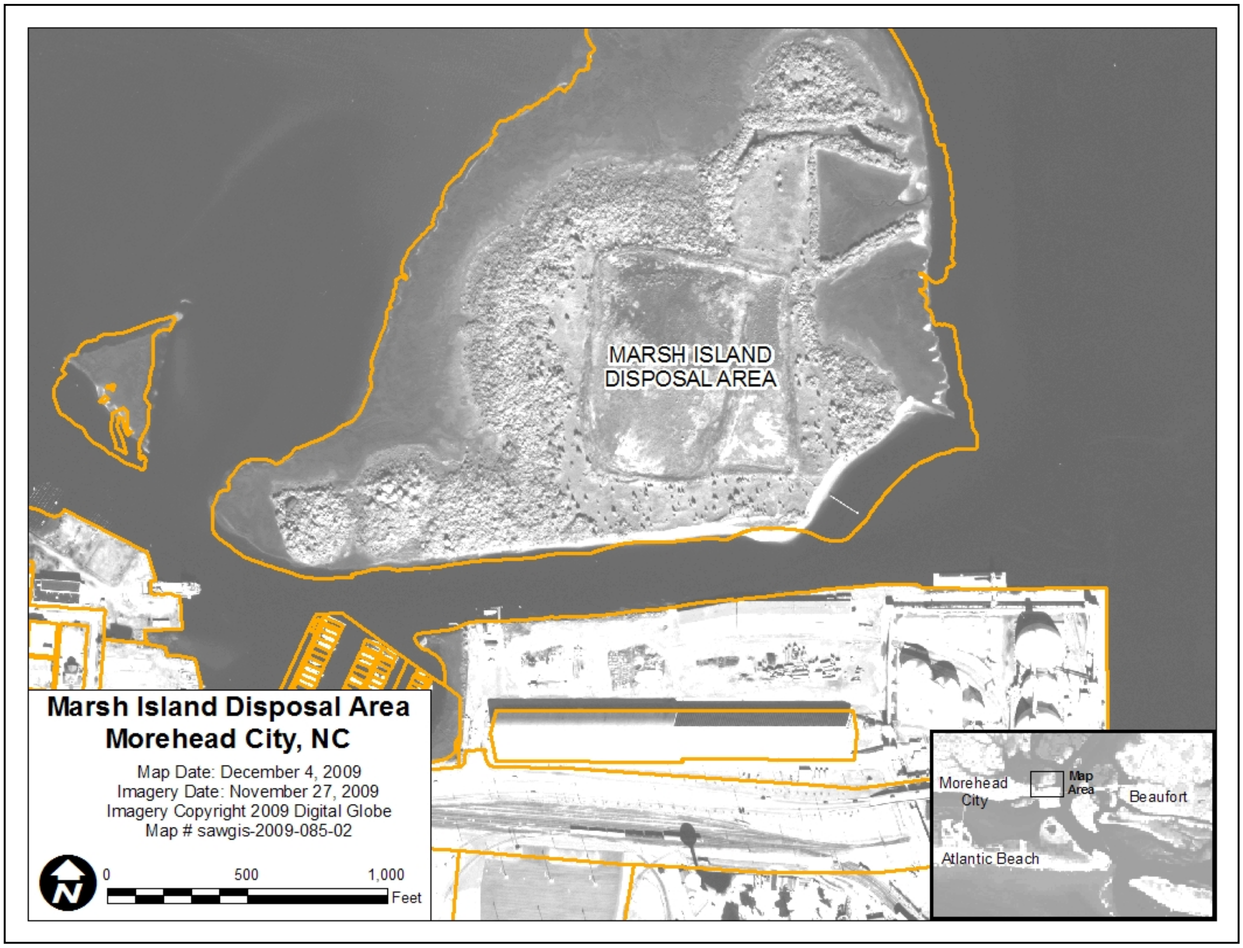


Figure 3-30. Marsh Island Disposal Area

3.2.6.8 Use Dredged Material to Create Wetlands

Description: The marshes of Bogue Sound are important habitat for fish and wildlife resources and support recreational and commercial activities that rely on these resources. Some of the marshes are eroding in the project area. These marshes provide an important function as nursery habitat for estuarine fish and shellfish and support a rich and diverse benthic fauna. The fish, invertebrates, and plant detritus produced within the marsh are important components of the food web, essential for the production of seafood which helps support recreational and commercial marine activities in the area. Studies in Louisiana have shown that the area of intertidal wetland is directly proportional to the commercial shrimp harvest (Turner 1979). Many species of birds and mammals are also supported by the marshes of Bogue Sound.

The construction of shallow water marsh habitat may significantly enhance feeding opportunities for migrant waterfowl, shorebirds, wading birds, and mammals.

In addition to the environmental benefits provided by creating marshland, the construction of the proposed marsh would protect existing marsh from continuing erosion and overwash from boat wakes and would help stabilize the Harbor area.

The Morehead Harbor DMMP PDT looked at other possible measures for the placement of dredged material within intertidal areas of Bogue Sound. The construction of shallow water marsh habitat in Bogue Sound would be a beneficial use of dredged material (in accordance with Section 204 Program (Beneficial Use of Dredged Material for Ecosystem Restoration) of the Water Resources Development Act of 1992.

Issues:

1) Dredged material volumes - The volume of material that would be needed to create wetlands, relative to the quantities removed annually from the Harbor channel, are miniscule and would not provide a cost effective dredged material disposal option.

2) Dredge equipment - Maintenance dredging of Morehead City Harbor is typically accomplished by a large pipeline dredge or hopper dredges. These large floating plants cannot operate safely in the shallow areas required for wetland creation and employing smaller dredge equipment or barges for the purpose of creating wetlands would not be feasible.

3) Resource Agency Concerns - The North Carolina Division of Water Quality has designated Bogue Sound as an Outstanding Resource Water (ORW) due to the high quality waters. Obtaining approval from the State to convert portions of existing shallow water habitat to marsh habitat would be very challenging, if not impossible.

4) Cost - Based on experience in doing similar wetland creation projects within Wilmington District, the estimated average per acre cost would be about $240,000. This cost only considers the actual construction of the wetlands and wetland planting and does not include additional costs that would be incurred to modify the disposal methodology (typical equipment is too large) nor the costs to monitor wetland success, which would be required by the resource agencies. Considering all potential costs, this measure would be considerably more costly than the base plan.

Conclusion: For the reasons described above, this measure was eliminated from further consideration in the DMMP. However, wetland creation using dredged material may be pursued under separate federal authority.

3.2.6.9 Construct a New Upland Disposal Site

Description: Another measure considered for the Morehead City Harbor DMMP was the construction of a new upland disposal site. To be viable, a new site would have to be at least as large as Brandt Island (~168 acres) and similar in proximity to the Harbor as the existing Brandt Island disposal site. Aerial photography of the area was used to identify any potential future sites 150-200 acres in size within a radius of 2 miles of the Harbor (Figure 3-31).

Issue: Analysis of aerial photography within a 2 mile radius of the Morehead City Harbor reveals that there are no undeveloped uplands of the size required to construct a new disposal site.

Conclusion: Due to a lack of undeveloped uplands in the Harbor vicinity, construction of a new disposal site is not viable. Even if land was available, the cost to purchase the land and construct a new site would be greater than the base plan. Due to the close proximity of Brandt Island and the ODMDS, any upland alternative would be more costly to construct and utilize than disposal in Brandt Island or the ODMDS. For these reasons, construction of a new upland disposal site was eliminated from further consideration. It should be noted that if land was available, creation of several smaller upland sites to meet the disposal needs of the Inner Harbor would be more costly than creation of one large upland site.

Figure 3-31. Area Considered for New Upland Disposal Site

3.2.6.10 Brandt Island Shoreline Stabilization

Description: One measure considered to potentially reduce dredging in the Morehead City Harbor navigation channels was the stabilization of the Brandt Island shoreline. In an attempt to identify the cause of the persistent shoaling within the Inner Harbor of the Morehead City Harbor navigation channel, an analysis of historic shoreline changes along Brandt Island was completed. Figure 3-32 is a vicinity map of Brandt Island that includes the shoreline transects used in the study to measure changes in the shoreline.

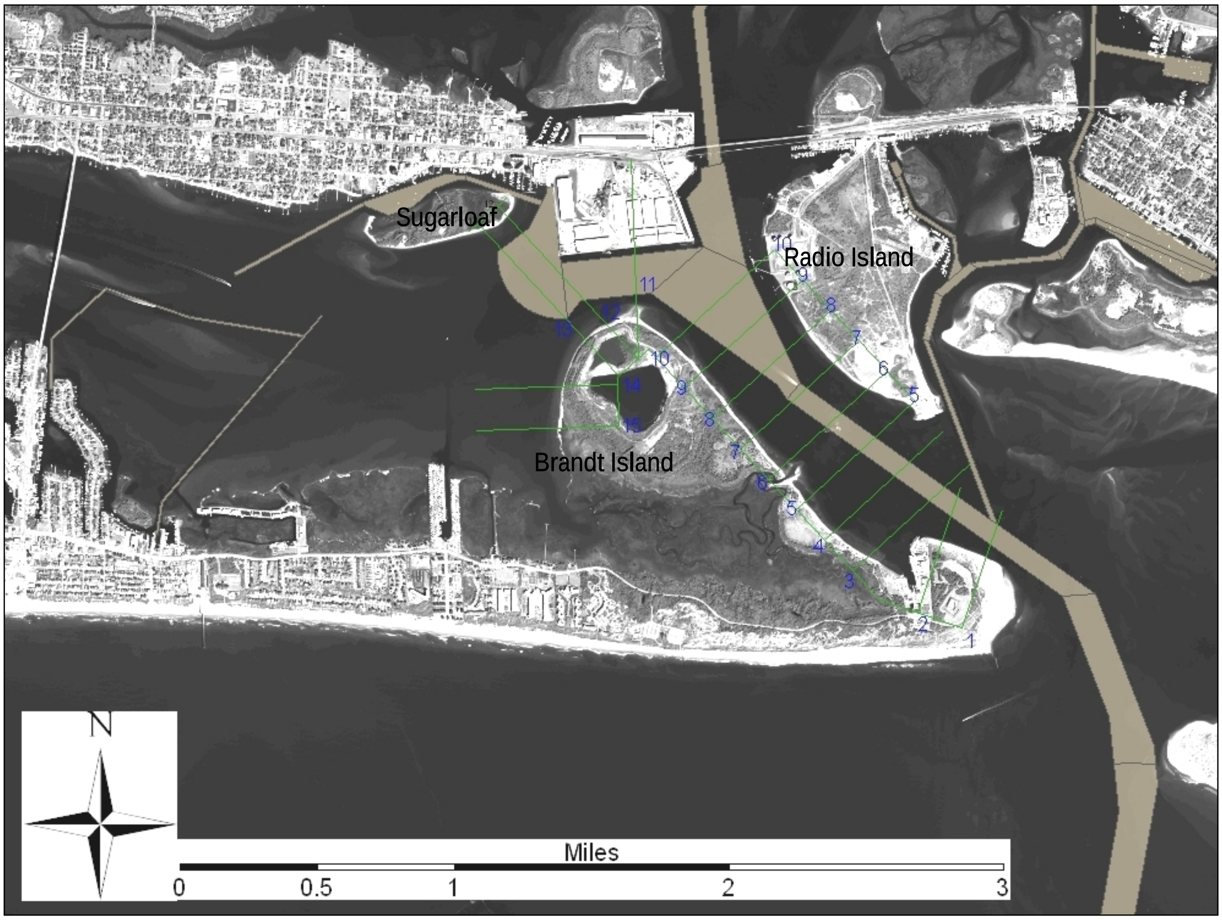


Figure 3-32. Brandt Island Shoreline Transects

The shorelines used in the analysis were extracted from historic aerial photography for this area from the following years:

1. May 1958 – 9" x 9" scanned prints
2. January 1964 – 9" x 9" scanned prints
3. August 1971 – 9" x 9" scanned prints
4. April 1974 – 9" x 9" scanned prints
5. June 1978 – 9" x 9" scanned prints
6. October 1988 – 9" x 9" scanned prints
7. Digital Orthophoto Quarter Quads (DOQQ) 1993 - orthorectified
8. DOQQ 1998 - orthorectified
9. October 2000 – 9" x 9" scanned prints
10. June 2002 – 9" x 9" scanned prints
11. February 2004 - orthorectified
12. January 2008 - orthorectified

The scanned prints were best-fit rectified using the January 2008 orthorectified image as control. Some error is to be expected in this process depending upon the prominence and number of features visible on both the scanned prints and the January 2008 orthorectified image used as control. Some of the photos did <u>not</u> cover the entire shoreline of Brandt Island, however these photos were incorporated to the maximum extent possible.

Shorelines were obtained from the photography through heads-up digitization for each of the photos and compiled in an ArcView shape file format. In addition to shorelines, a vegetation line and a “shoal line” (or shallow water break line) were also digitized. The shoreline and vegetation lines are rather easy to interpret compared to the shoal line. The distinction of a shoal line is highly dependent upon the clarity of the water, the tide level and currents at the time of the photo. For this part of the analysis, only the shoreline was used for further study. Shorelines for Radio Island, the Port of Morehead City and Sugarloaf Island (Figure 3-32) were digitized as well.

An arbitrary reference line was established from which perpendicular distances to the digitized shoreline were measured. An additional non-perpendicular line was included to capture shoreline measurements along the north shore of Brandt Island. The Brandt Island shoreline to reference line measurements are presented in Table 3-10.

Year	1958	1964	1971	1974	1978	1988	1993	1998	2000	2002	2004	2008
Brandt01	n/a	n/a	n/a	n/a	1,056	n/a	n/a	n/a	1,451	n/a	1458	1,422
Brandt02	1305	n/a	n/a	1,338	1,346	n/a	n/a	n/a	1,468	n/a	1437	1,449
Brandt03	734	711	605	609	561	n/a	n/a	n/a	413	422	390	412
Brandt04	652	591	261	262	247	n/a	n/a	n/a	228	240	219	238
Brandt05	370	427	428	448	398	233	285	n/a	246	245	228	248
Brandt06	292	265	212	403	490	418	260	333	303	309	320	321
Brandt07	438	445	312	367	349	211	370	366	346	347	357	360
Brandt08	439	389	367	416	385	266	415	426	380	370	397	420
Brandt09	374	431	386	n/a	439	329	479	471	436	412	444	467
Brandt10	362	510	382	n/a	467	341	442	462	n/a	381	434	442
Brandt11	420	800	512	n/a	633	594	701	685	n/a	n/a	723	800
Brandt12	362	1,015	827	n/a	1,059	866	895	914	n/a	n/a	891	885
Brandt13	129	794	851	n/a	1,054	1,044	996	991	n/a	968	934	954
Brandt14	44	497	949	1,136	1,101	1,180	1,105	1,103	1,103	1,103	1069	1,037
Brandt15	n/a	286	1,000	1,082	1,093	1,276	n/a	n/a	1,167	1,204	1187	1,160

Table 3-10. Distances from Reference Line to Shoreline – Brandt Island

The western shoreline of Radio Island and the southern shoreline of Sugarloaf Island were also digitized and measured in relation to a reference line. The reference line to shoreline distances are tabulated in Table 3-11 below:

Reference Line	Year	1958	1964	1971	1974	1978	1988	1993	1998	2000	2002	2004	2008
	Radio05	342	226	174	n/a	110	n/a	n/a	79	135	n/a	108	129
	Radio06	495	654	636	n/a	550	n/a	n/a	531	553	534	502	514
	Radio07	242	315	497	n/a	507	867	n/a	626	n/a	688	643	655
	Radio08	328	500	n/a	n/a	516	804	507	566	n/a	657	589	618
	Radio09	390	445	n/a	n/a	406	n/a	382	390	n/a	n/a	390	412
	Radio10	144	143	n/a	n/a	154	n/a	143	147	n/a	n/a	160	152
	Sugarloaf12	499	456	n/a	n/a	426	n/a	371	339	n/a	n/a	275	288
	Sugarloaf13	343	236	n/a	n/a	246	n/a	177	215	n/a	n/a	184	197

Table 3-11. Distances from Reference Line to Shoreline - Western Shore Radio Island / Southern Shore Sugarloaf Island

Figure 3-33 shows the location of reference lines and digitized shorelines overlaid on January 2008 photography. Note how the 1958, 1964 and 1971 shorelines show expansion of the north and west part of Brandt Island. During this timeframe the island was built up with dredged material in an uncontrolled manner until dikes were constructed to contain and control the deposition of dredge material. The island has retained its general shape since the late 1970's.

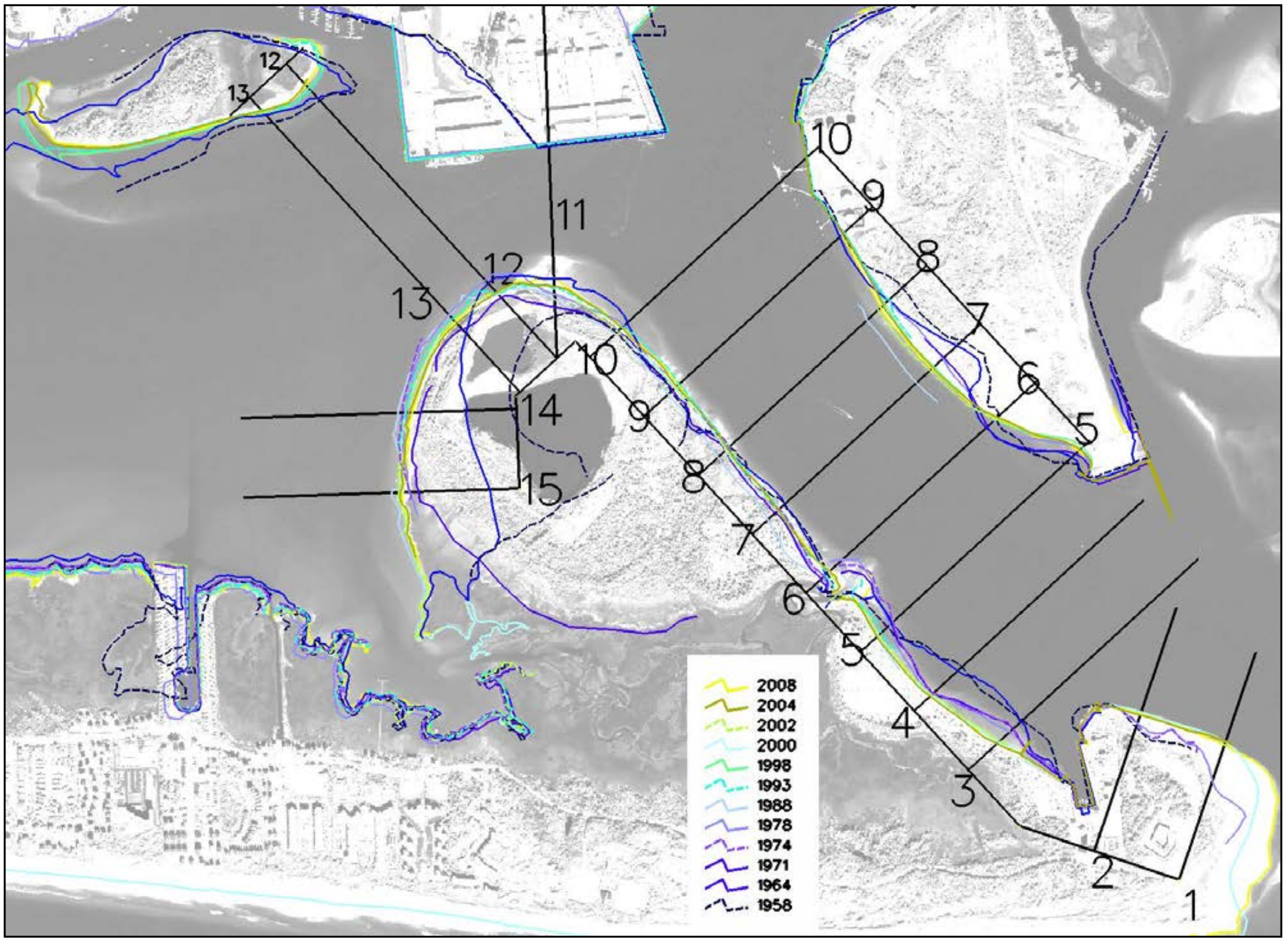


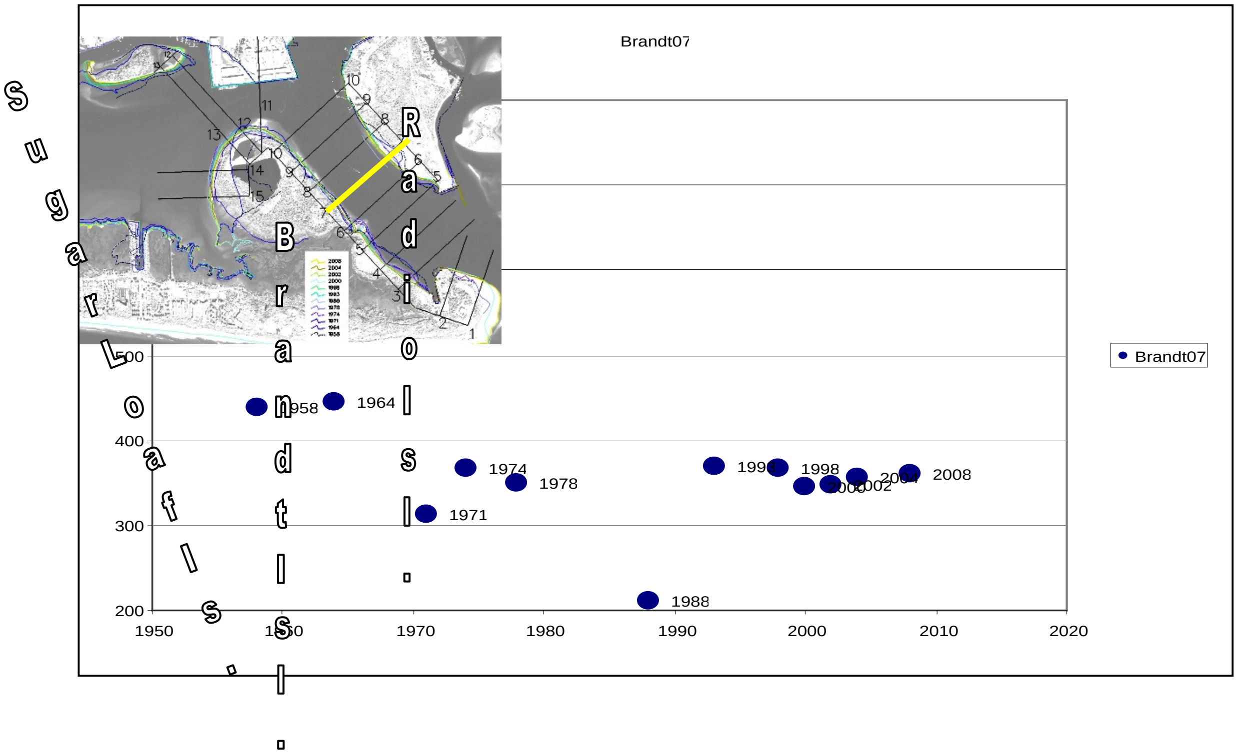
Figure 3-33. Reference Lines and Historical Shorelines

Plots are provided below showing the variation of distance from the reference line to the shoreline over time. This graphical plot helps to quickly discern any trends in shoreline movement over time.

The plots for reference lines 7 and 9 are shown in Figure 3-34. Reference lines 7 and 9 are generally representative of the adjacent reference lines along this east shore of Brandt Island and fail to show consistent erosion or accretion.

Figure 3-35 shows the shoreline distance plot for reference line 11. This plot shows a buildup of shoreline and is attributed to the proximity to an outfall pipe which drains the diked area. The outfall pipe is elevated with a timber structure which tends to trap migrating sediment.

Figures 3-36 and 3-37 show the shoreline distance plot for reference lines 14 and 15. The shoreline at reference line 14 and northward appears to be retreating according to the last several data points. This part of the island is exposed to the longest fetch distances and likely experiences larger wind driven waves.



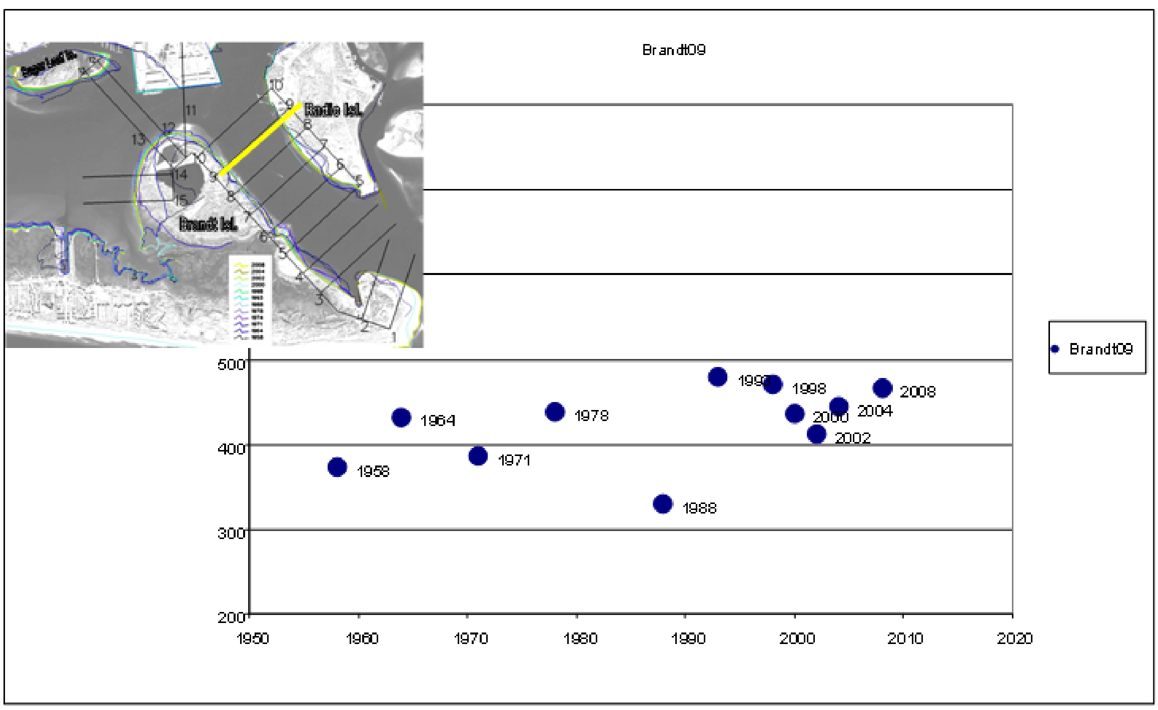


Figure 3-34. Reference Line to Shoreline distance vs. Time; Lines 7 and 9 Brandt Island

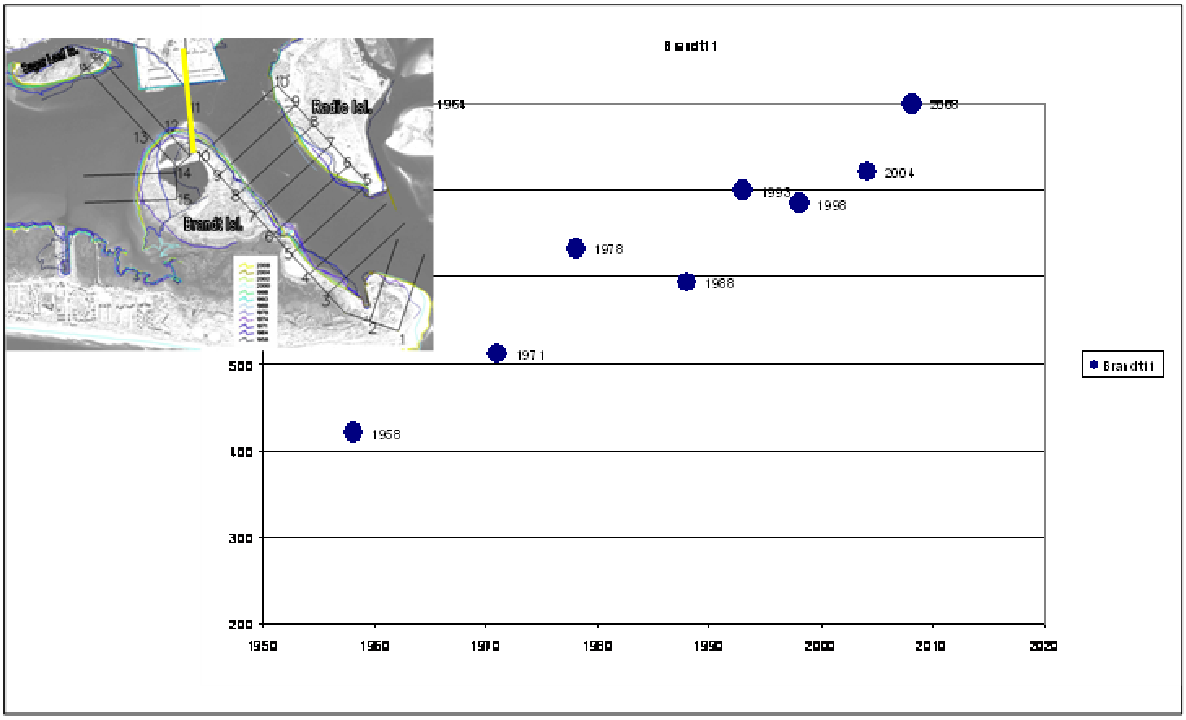


Figure 3-35. Reference Line to Shoreline distance vs. Time; Line 11 Brandt Island

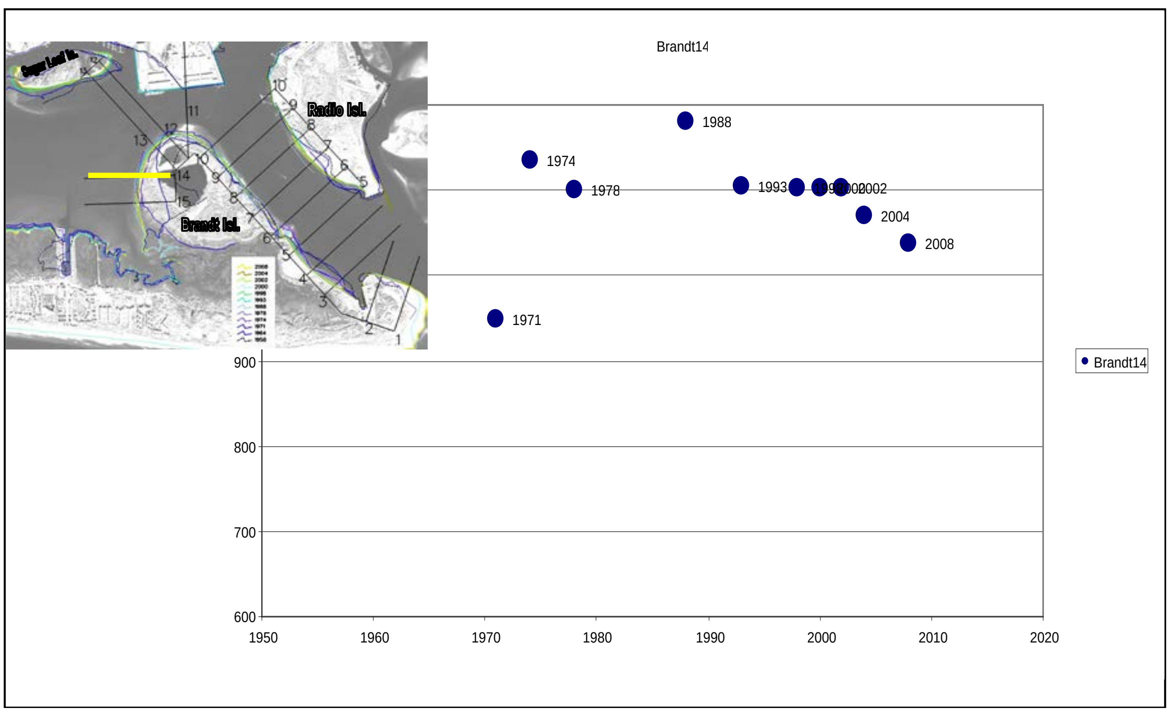


Figure 3-36. Reference Line to Shoreline distance vs. Time; Line 14 Brandt Island

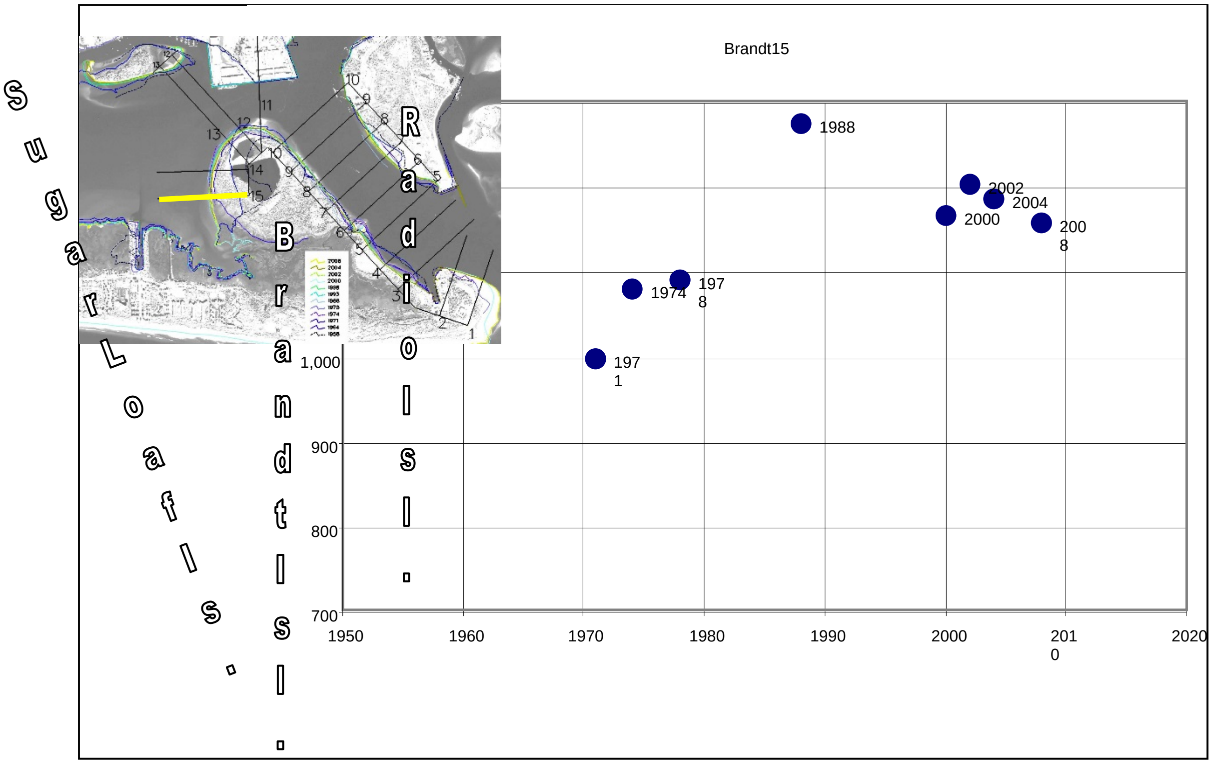


Figure 3-37. Reference Line to Shoreline distance vs. Time; Line 15 Brandt Island

Issue: With the exception of two areas: 1) The eroding shoreline facing West-Northwest (line 14) and 2) The accreting shoreline near the original outfall pipe (line 11), the Island shoreline appears to be relatively stable.

Conclusion: Due to the limited change observed within this analysis, a shoreline stabilization measure was not evaluated further.

3.2.6.11 Construct Jetties at Beaufort Inlet

Description: One measure considered to reduce shoaling within the navigation channel and retain sediment within the littoral flow was the construction of a jetty and sand bypassing system at Beaufort Inlet. Jetties are shore-connected structures typically constructed perpendicular to the shore and extending into the ocean which confine stream or tidal flow, thus reducing shoaling and dredging requirements, (USACE 2002). In addition to reducing shoaling within the channel, jetties serve to reduce longshore current and attenuate wave heights within the channel, which improves navigational safety.

Construction of jetties at Beaufort Inlet would produce impacts that are both predictable and unpredictable. One of the predictable impacts that would result from an obstruction in the nearshore would be shoreline accretion on the updrift side of the jetty followed by shoreline recession on the downdrift side of the jetty complex. To compensate for this blockage in the natural littoral flow, a sand bypassing system would be necessary to mechanically transport sand around the inlet on a periodic basis. There are several methods to accomplish this mechanical bypassing which include: mobilizing conventional dredge pumps on an as needed basis to clear the accumulation of sand on the updrift side of the inlet and transport it by pipeline to the downdrift location; construction of a permanent sand bypassing plant similar to that built at Indian River Inlet, DE where a jet pump is operated on a regular schedule to continually remove trapped sand to the downdrift side of the inlet, (USACE 2002); or by a bucket and barge operation where material could be dredged into a barge and then released in the nearshore placement area on the downdrift side of the inlet. Other impacts could include changes in the tidal prism and back bay erosion along the landward terminal end of the jetty.

Issue: Pursuant to Policy Guidance Letter 40, Development and Financing of Dredged Material Management Studies, dated 25 March 1993, management plan studies for existing projects shall be conducted pursuant to existing authorities for individual project operation and maintenance, as provided in public laws authorizing specific projects. New projects or project modifications beyond the O & M of the authorized project (Morehead City Harbor navigation project), require congressional authorization and should be pursued as cost shared feasibility studies with General Investigations funding. Where the need for such modifications are identified as part of dredged material management studies, operation and maintenance funding for the study of the modification should be terminated and a new feasibility study start sought through the budget process under the authority of Section 216 of the 1970 WRDA .

Conclusion: This measure is outside the scope and authority of DMMPs and therefore was eliminated from further consideration. As stated above, this measure may be pursued under separate federal authority.

3.2.6.12 Modify Existing Terminal Groin on West Side of Beaufort Inlet

A measure proposed during an early DMMP development meeting with the public was to rehabilitate or modify the terminal groin located on the east end of Bogue Banks in the vicinity of Fort Macon State Park. This structure, which was built in the early 1960's by the state of North Carolina, was intended to stabilize the shoreline that fronts the historic Fort Macon State Park.

Terminal groins are designed to retain sand and provide additional shoreline as a protective measure and/or to provide recreational area. Once the structure has retained sand to its designed width, it allows for natural bypassing of material downdrift of the structure. Material bypassing the Fort Macon State Park terminal groin is generally deposited within the navigation channel, however some material has accumulated on the east end of Bogue Banks resulting in recently observed spit growth which is encroaching on the Morehead City Harbor navigation channel. While the original design documents were not available at the time of this report, the structure appears to be an extension of a smaller groin within the existing groin field shown in Figure 3-38. The existing groin field is shown in the 1958 and 1962 photographs within 3-38 and the earliest available photography showing the newly constructed terminal groin is shown from 1974, also in Figure 3-38.

A photographic comparison is shown in Figure 3-38 that clearly shows the positive influence of the structure on the shoreline within the vicinity of Fort Macon State Park. The shoreline on the eastern end of Bogue Banks adjacent to the terminal groin accreted approximately 700’ between 1958 and 1974 as a result of the groin construction. The 1974 shoreline is overlaid on the August 2009 photography within Figure 3-38 to display how the shoreline in the vicinity of the terminal groin is in virtually the same location as it was in 1974. Further examination of available photography between 1974 and 2009 (Figure 3-39) shows that the shoreline is subject to cycles, beginning with accretion just after beach placement along Bogue Banks followed by shoreline recession which reduces the shoreline approximately back to the 1974 position for the eastern 2000 feet of the island. This consistent minimum shoreline position in the area adjacent to the terminal groin would indicate that the groin is functioning much in the same way as it did when first constructed.

Issue: Since it appeared through this initial investigation that the terminal groin was operating much as it did when built, a rehabilitation of the structure does not appear necessary. To improve the groin functionality and possibly increase its ability to retain sand would require a detailed study of the structure including reviews of the initial design and purpose, existing wave and current patterns impacting the structure, physical structure surveys, and an analysis of environmental impacts related to changes of the structure length and porosity.

Conclusion: Due to the fact that the structure is not property of the federal government and these study items are beyond the scope of the DMMP, this measure was deemed not feasible at this time. As a separate project, the Wilmington District USACE in conjunction with the U.S. Army Engineer Research and Design Center is developing a wave and current model of Beaufort Inlet which includes the groin at Fort Macon State Park. This model, once developed, would be available for incorporation into future studies of the terminal groin.

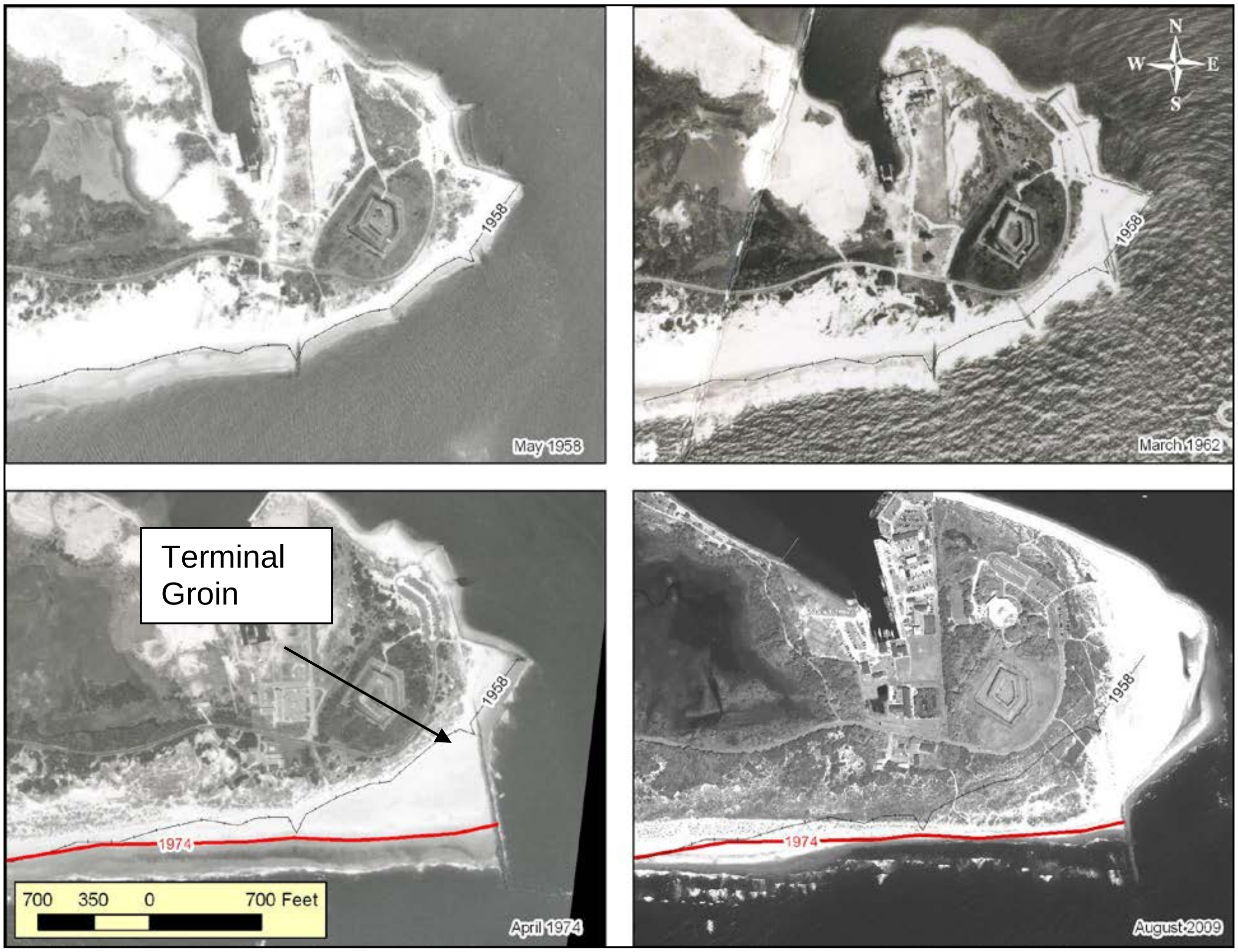


Figure 3-38. Fort Macon State Park Pre- and Post-Groin Construction

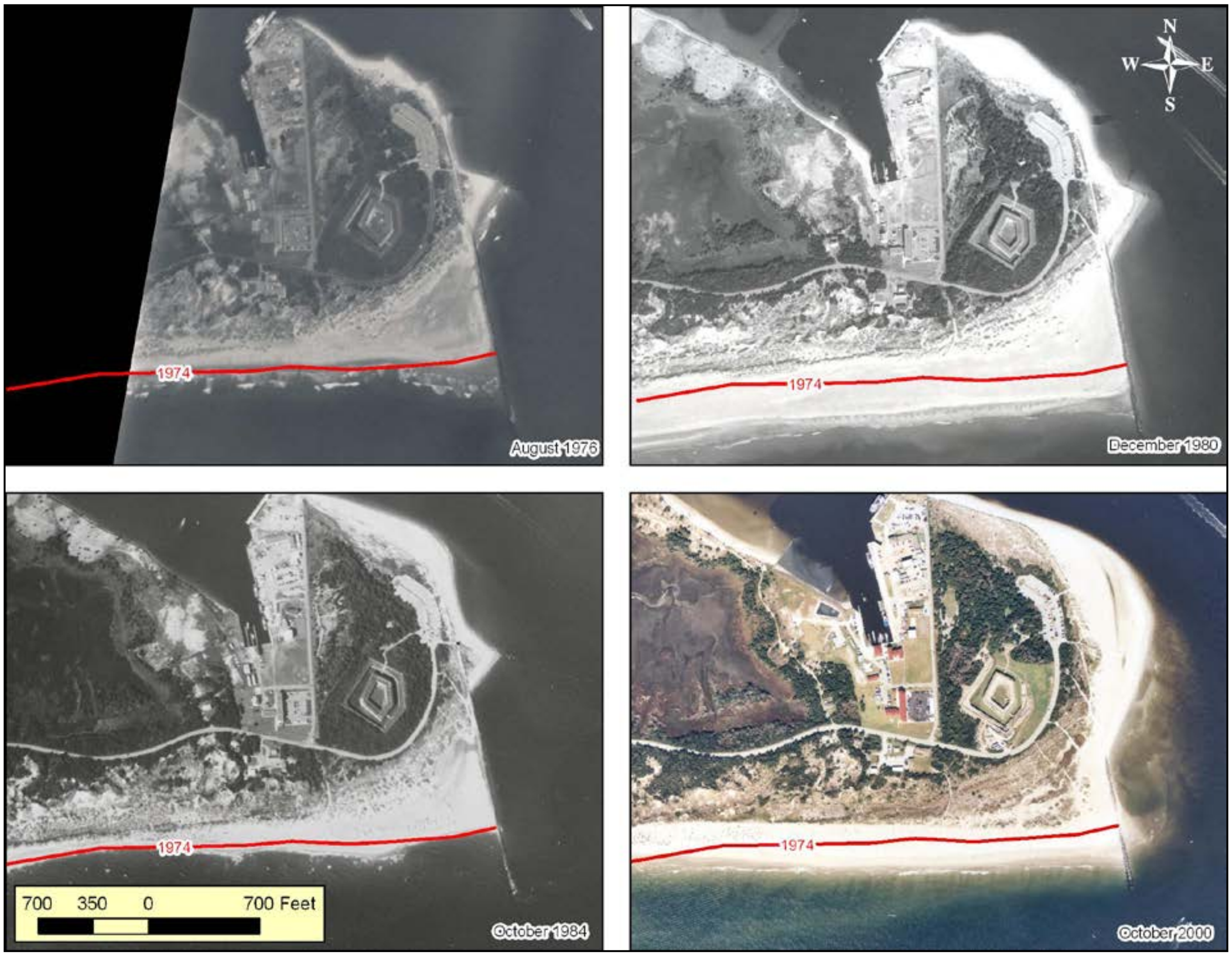


Figure 3-39. Fort Macon State Park Shoreline Fluctuation

3.2.6.13 Realign Morehead City Harbor Navigation Channel

Description: To reduce dredging requirements within the Morehead City navigation channel, an investigation into realigning the channel to follow natural flow patterns was suggested at a public discussion early in the DMMP process. An initial review of this proposal included a comparison of available historic bathymetric data from 1974, 1998, 2005, and 2009, which clearly shows that the ebb tide delta has deflated since 1974. In addition, the deflation patterns observed indicate that flow through the Inlet has caused extensive scour in two areas of the ebb tide delta, as shown in Figure 3-40. The probable cause of these scour areas is a redirection of current from the maintained navigation channel to a north-northwest orientation. This current jetting across the eastern lobe of the ebb tide delta results in material being removed from the existing ebb tide delta and deposited in deeper water, just south of the eastern ebb tide delta where velocities are much lower.

While the observed changes in bathymetric data within the ebb tide delta are a good indicator of current patterns, they do not replace the need for accurate current measurements and modeling of flow patterns within the Inlet complex. Sand deposition within the Inlet complex can affect the flow patterns, which may result in changes in the main ebb channel. These sand depositions may be the result of direct placement of material within the ebb tide delta or natural changes. Deposition of dredged material within the Nearshore Placement Area is an example of direct placement. A natural deposition can be observed on the east end of Bogue Banks where the spit has grown considerably, toward the navigation channel, since the early 1990's. This spit growth toward the channel could possibly be one cause for the redirection of the current to a more north-northwest alignment. Similarly, the point of the spit on Shackleford Banks has accreted toward the navigation channel and could be impacting the inlet velocities and channel orientation.

Current and sediment transport modeling within the Beaufort Inlet complex would provide guidance to help determine the most sustainable channel orientation through the ebb tide delta. By adjusting the channel orientation to match the current flow patterns, shoaling of the navigation channel and therefore dredging requirements may be minimized. In addition, it would provide information on movement of material placed within the ebb tide delta and allow modification of placement areas and lift thickness to maximize the benefits of the placed material on the ebb tide delta. Currently the Wilmington District USACE, in conjunction with the U.S. Army Engineer Research and Development Center, is developing such a model for the Beaufort Inlet complex. The model would be available, when complete, to attempt to answer some of these questions.

Issue: The ability to undertake a study which would analyze and recommend changes to the Morehead City Harbor navigation channel orientation is not within the scope of the DMMP.

Conclusion: Pursuant to USACE policy, DMMPs may only address O&M of the currently authorized project and may not recommend changes to that project, with the exception of considering reduced channel dimensions, therefore, realignment of the navigation channel was not pursued further as part of the DMMP. However, realignment may be pursued under a separate authority.

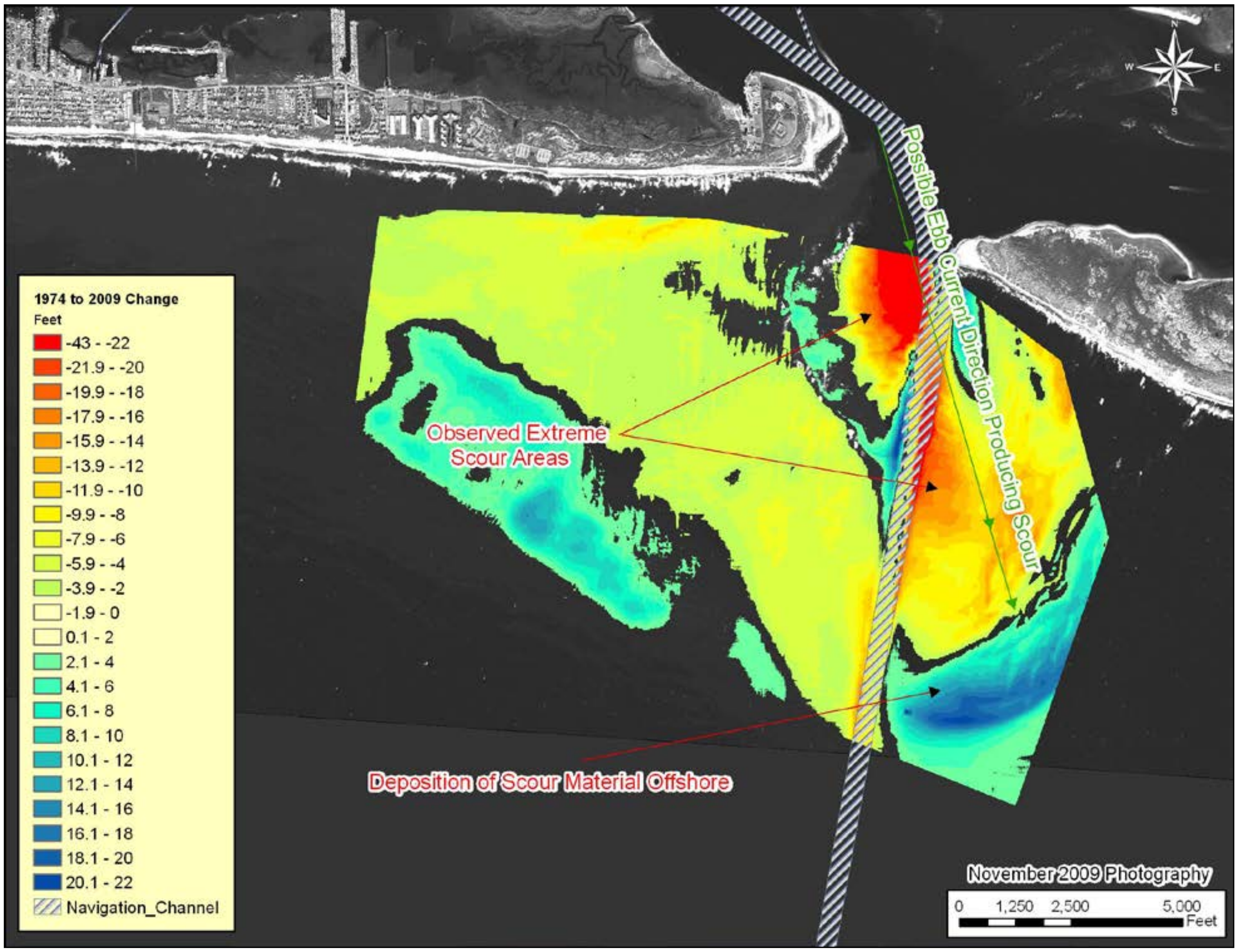


Figure 3-40. Elevation Difference Plot - 1974 to 2009

3.2.6.14 Reduce Channel Dimensions

Description: To reduce maintenance dredging costs for the Morehead City Harbor navigation channel, the PDT considered the option of narrowing or reducing the depth of the channel.

Issue: The 1992 Design Memorandum (USACE 1992), which addressed modifications to the Morehead City Harbor navigation channels, included several wideners to improve ongoing maintenance as part of the project that involved deepening from 40 to 45 feet in the interior channels. There were 3 wideners included in Range A, and the report states "These channel wideners are all needed with or without the project and are incrementally justified based on safety, economic considerations or both." Since wideners are needed, even at the 40-foot depth, narrowing the channel is not recommended.

The Navy/Marine Corps considers the Port of Morehead City a strategically critical site. Ideally, the Navy would prefer the Morehead City channel be widened to 600 feet (U. S. Navy 2002). This reinforces the requirement to retain existing channel widths.

Additionally, an analysis of vessel trips and drafts was done to determine channel utilization. Channel usage at a draft of 42 feet would require the authorized channel, and several vessels over the last few years have drafted about 42 feet.

Conclusion: Based on usage of the Port and its importance to the military, the option of reducing channel dimensions (width or depth) was eliminated from further consideration.

3.2.6.15 Construct Terminal Groin on Shackleford Banks

Description: One measure proposed by the public during DMMP development was the construction of a terminal groin on the west end of Shackleford Banks to help retain sand on Shackleford Banks.

Issue: In appropriate circumstances, terminal groins can work to the benefit of navigation projects. The impacts on adjacent beaches are often less certain to predict, and it can be a major undertaking to evaluate the potential effects of such projects on adjacent shorelines and the affected biotic communities. The major constraint preventing consideration of a terminal groin in the DMMP is Policy Guidance Letter (PGL) No. 40, which discusses the content and funding of DMMP efforts. Specifically, PGL No. 40 states that "management plan studies for existing projects shall be conducted pursuant to existing authorities for individual project operation and maintenance, as provided in public laws authorizing specific projects." Consideration of a new terminal groin would fall outside the existing authority for this DMMP. Specifically, such modification is not within the narrow range of navigation project modifications that would be exempt from congressional approval, as outlined in Engineer Regulation 1165-2-119. The PGL explains further that:

> "Studies of project modifications needing congressional authorization, including dredged material management requirements related to the modification, will be pursued as cost shared feasibility studies with General Investigations funding. Where the need for such modifications are identified as part of dredged material management studies, operation and maintenance funding for the study of the modification should be terminated and a new feasibility study start sought through the budget process under the authority of Section 216 of the Water Resources Development Act (WRDA) of 1970."

Terminal groins, jetties, and other potential navigation project modifications would appropriately be considered in a new feasibility study cost shared with the project sponsor, in this case the State of North Carolina, and not as part of a DMMP, which uses funds for Operation and Maintenance (O&M) of completed navigation projects. Initiation of a feasibility study to consider such modifications would require not only the concurrence of the cost-sharing sponsor, but also congressional authority to initiate the study using General Investigations (GI) funding.

Based on coordination with the National Park Service (NPS), it is also apparent that constructing a terminal groin on the east side of Beaufort Inlet as an alternative in the DMMP would likely be incompatible with National Park Service (NPS) policy. Section 4.8.1.1 of the 2006 NPS Management Policies pertains to shorelines and barrier islands. This section states that:

> "Natural shoreline processes (such as erosion, deposition, dune formation, overwash, inlet formation, and shoreline migration) will be allowed to continue without interference. Where human activities or structures have altered the nature or rate of natural shoreline processes, the Service will, in consultation with appropriate state and federal agencies, investigate alternatives for mitigating the effects of such activities or structures and for restoring natural conditions…"

The evaluation of a new terminal groin would not further the NPS policy of restoring natural processes and conditions nor would it likely be compatible with NPS wilderness policies, which permit management intervention to correct for human impacts, but only to the extent necessary and consistent with the minimum requirement concept (see, e.g., NPS Management Policies, Sections 6.3.5 and 6.3.7). A structure such as a terminal groin would not likely meet these protective criteria, particularly in light of funding limitations or other factors which may reduce the frequency and/or volume of sediment disposal.

Conclusion: Construction of a terminal groin on the west end of Shackleford Banks is both beyond the scope of this DMMP and is unlikely to be found compatible with NPS policies. Therefore, this option was eliminated from further consideration.

<u>3.2.6.16   Place Inner Harbor Material ≥80% Sand in Nearshore Placement Areas</u>

Description: To date, only dredged material that contains at least 90% sand has been placed in the existing Nearshore West. The DMMP considered placement of Inner Harbor material that was at least 80% sand in the existing and proposed nearshore placement areas. This would keep more material in the littoral system, which may help ameliorate ebb tide delta deflation. This option would also prolong the life of Brandt Island.

Issue: Draft DMMP comments received from the National Marine Fisheries Service (NMFS) including the following: "NMFS is unlikely to support nearshore placement of material with a high concentrations of fine material and supports an environmental window for bucket to barge dredging of inner harbor material. Exposure to high concentrations of suspended sediments may, depending on exposure duration, decrease larval feeding rate, damage the epidermis of larval fishes, and increase larval mortality (Wilber and Clarke 2001). Mechanical (bucket to barge) dredging yields higher concentrations of suspended sediments than either hopper or pipeline dredges, and mechanical dredges can cause this impact throughout the water column. Further, this method of dredging has been observed to produce large amounts of suspended sediments in the confined area of the Morehead City Inner Harbor, especially in the Northwest, West, and East legs."

Conclusion: Due to NMFS concerns and the fact that placement of 80% sand in the nearshore areas was not the least cost option for disposal of this material and the small volume of material would provide minimal benefit to the ebb tide delta, the USACE has eliminated this measure from the DMMP.

3.2.6.17 Placement of Coarse-Grained Material on Shackleford Banks

Description: Since the 1970's, the USACE has recognized that dredging of the Morehead City Harbor channel has detrimental effects on the natural sediment balance of the Beaufort Inlet Complex, which includes the ebb tide delta and beaches on both sides of the Inlet. For this reason, the USACE has recommended since 1978 that the beach-quality sediment dredged from the navigation channel be placed on Bogue Banks and Shackleford Banks. Shackleford Banks, a part of the Cape Lookout National Seashore, is managed by the National Park Service (NPS), and in the past, the NPS did not want sand from the channel placed on Shackleford Banks. As a result of new information regarding navigation channel impacts on Shackleford Banks, in 2010, the NPS requested that sand placement on Shackleford Banks be considered in the DMMP. Therefore, the draft DMMP included placement of beach quality dredged material on Fort Macon State Park, Atlantic Beach and Shackleford Banks.

Issue: Following circulation of the Draft DMMP, the NPS requested dismissal of the alternative to place dredged material on Shackleford Banks during the time span of the DMMP. The NPS indicated the following reasons:

- While recent surveys have shown that the offshore profiles along Shackleford Banks have experienced a loss in sediment volume, the amount of sediment volume loss that has resulted from maintenance activities of the Morehead City Harbor Channel, rather than natural processes, has not been determined. The data is not available to distinguish between background losses versus losses caused by the navigation channel.

- NPS agreed with USACE that the sediment budget and shoreline processes along Shackleford Banks are not completely "natural" because of the navigation channel. The DMMP/EIS analyzed alternatives for restoration or mitigation of human-impacted shoreline processes. However, the analysis in the DMMP does not indicate that the placement would *restore* or *mitigate* the impacts of the channel because of the nature of the dredged material, the quantities proposed, the long-term sea level rise in this area, and the processes of Shackleford Banks. The placement of the dredged material under the DMMP may reduce channel-related impacts but may not restore natural conditions or completely mitigate the impacts of the channel.

- NPS would prefer to have a larger database through continued monitoring through profile surveys to determine if the sediment volume loss of approx. 166,450 cubic yards per year, as calculated from 5 surveys from 2000 to 2010, continues in this trend.

- Shackleford Banks is proposed wilderness, and in accordance with NPS policies, management intervention should only be taken when there is knowledge that will result in mitigating past mistakes, impacts of human use and influences outside the proposed wilderness boundary and where the gains from mitigation outweigh the effects of sand placement. Based on the analysis, the NPS cannot make this determination.

Conclusion: The long-term effects of disposing of sand on only one side of Beaufort Inlet are not conducive to the long-term sustainability of the channel or the Inlet complex; therefore, the USACE continues to recommend placement of sand on Shackleford Banks. However, as requested by the NPS, no beach-quality dredged material will be placed on Shackleford Banks as part of this DMMP.

3.3 Costs of the Alternative Plans

Cost estimates were developed for each of the DMMP measures and are included in Appendix G. Cost was a criterion used to develop a suite of DMMP measures that would provide adequate disposal capacity to maintain the Harbor to its fully-authorized dimensions for at least the next 20 years. The estimates are detailed dredging estimates, except for dike raises, which were based on historic costs.

1. Cost Estimates were prepared under guidance given in the USACE Regulation ER 1110-2-1302, Civil Works Cost Engineering and Engineering Instructions, ETL 1110-2-573, Construction Cost Estimates.

2. The cost estimates are based on the October 2014 price level and current fuel prices as quoted by local distributors.

3. Dredging estimates were completed using the USACE Dredging Estimating Program (CEDEP).

   a. CEDEP considers details of dredged material characteristics, depth of dredged material, effective production time, distances from dredge sites to disposal/placement sites, cost of dredge plant equipment, operating, and labor and other economic adjustments for fuel and area factors.

   b. The location and features of dredge and disposal areas in relation to the channel ranges, as well as historical production, methods, and disposal considerations for similar projects, were used in conjunction with the CEDEP and Micro-Computer

Aided Cost Estimating System (MCACES – MII) programs for determining dredging and construction costs.

c. Each measure includes general assumptions for that range or construction required.

d. All embankment construction soil material was assumed to be from on-site taken from the existing dry dredged material and surrounding island native soil.

e. An average 27% contingency was included to represent unanticipated conditions or uncertainties not known at the time of the estimate and was developed as referenced in ER 1110-2-1302 for this level of estimate. The 27% contingency was developed using the abbreviated Cost Schedule Risk Analysis approved by the USACE Cost Engineering Center of Expertise, Walla Walla District.

4. Costs were evaluated over the 20-year planning period and were discounted at the 2015 federal discount rate of 3.375% using the end-of-year convention. Present worth was determined using a factor of 0.06957 for the 20-year planning period and applicable interest rate. Additionally, screening level costs were presented in an average per-cycle basis, while costs for the selected plan were presented as aggregate and average annual.

3.3.1 No Action Plan (No DMMP)

The “No Action” plan means status quo (continuation of the Interim Operations Plan indefinitely). The projected costs to implement the Interim Operations Plan are: Year 1 - $18 million, Year 2 - $8 million, and Year 3 - $8 million for a total of about $33 million every 3 years. Assuming No DMMP, the IOP 3- year cycle would be repeated indefinitely subject to additional coordination. As shown in the tables below, the Interim Operations Plan costs are lower than the proposed DMMP base plan. The main reason for this is that the IOP was designed to handle about 1 million cubic yards annually, which at the time was estimated to be the minimum volume required to be removed to keep the channel navigable (with only width restrictions). The primary difference in cost is due to the difference in volumes between minimum tolerances and the full-channel maintenance envisioned by this DMMP. Also, the IOP does not include placement of material in the ebb tide delta east of the Inlet. The average annual cost of the No Action Plan is about $12 million dollars and is shown by year in Table 3-12.

	Project Year	Annual Cost	Present Value
2016	1	$17,747,600	$17,748,000
2017	2	$8,198,700	$7,931,000
2018	3	$8,009,800	$7,495,000
2019	4	$17,747,6002	$16,065,000
2020	5	$8,198,700	$7,179,000
2021	6	$8,009,800	$6,785,000
2022	7	$17,747,600	$14,543,000
2023	8	$8,198,700	$6,499,000
2024	9	$8,009,800	$6,142,000
2025	10	$17,747,600	$13,164,000
2026	11	$8,198,700	$5,883,000
2027	12	$8,009,800	$5,560,000
2028	13	$17,747,600	$11,917,000
2029	14	$8,198,700	$5,325,000
2030	15	$8,009,800	$5,033,000
2031	16	$17,747,600	$10,787,000
2032	17	$8,198,700	$4,821,000
2033	18	$8,009,800	$4,556,000
2034	19	$17,747,600	$9,765,000
2035	20	$8,198,700	$4,364,000
			$171,562,000
		$11,935,000	

Table 3-12. Average Annual Costs of the No Action Plan

3.3.2 Proposed Measures

The costs per dredging cycle for each of the measures that comprise the base plan are discussed in the sections below. As demonstrated in the sections below, costs to implement the proposed base plan are somewhat higher than the cost of the No Action plan (IOP). Unlike the IOP, the DMMP is based on maintaining the Harbor to its fully authorized dimensions, thus resulting in the annual removal of approximately 1.3 million cubic yards of dredged material. For simplicity, in the tables below, measures that are similar, such as placement of material in the Nearshore West and East, and whose costs are the same, have been combined. In the costs shown below in Tables 3-12 through 3-17, the costs per dredging cycle include mobilization and demobilization. Following the discussion of the costs for each measure considered is a summary of the cost of the recommended base plan (Section 3.3.3, Summary of Least Cost Analysis).

3.3.2.1 Brandt Island

Disposal of Material from the Northwest Leg, West Leg 1 and the East Leg. As shown in Figure 2-2, the Harbor ranges have been divided into three categories: 1) fine-grained material less than 80% sand, 2) material that is between 80% and 90% sand, and 3) material that is greater than or equal to 90% sand. The Northwest Leg, a portion of the West Leg (referred to as West Leg 1) and the East Leg of the Inner Harbor contain fine-grained sediments (less than 80% sand) that may be disposed of in Brandt Island until it reaches capacity. Table 3-13 shows the costs for the viable measures considered for disposal of this material. Hopper dredges cannot work efficiently within the confines of the Inner Harbor. This is especially true near the berths; therefore, hopper dredging here is not a viable option and costs are not included below. As shown below, in this portion of the Inner Harbor, the cost for dredging with an 18-inch pipeline dredge on a three-year cycle, utilizing Brandt Island until it reaches capacity in 2028 would incur an average annual cost of approximately $744,000. Taking this material to the ODMDS (after Brandt Island reaches capacity in 2028) by bucket and barge would incur a cost of about $1,153,400.

ID #	Disposal Area	Dredging Method	Average Annual Cost
IH-1	Brandt Island	18-inch Pipeline	$744,300
IH-2	ODMDS	Bucket and Barge	$1,153,400

Table 3-13. Costs for Disposal from Northwest Leg, West Leg 1 & East Leg

Disposal of Material from the West Leg 2 and North Range C. Material from the West Leg 2 and North Range C contains a mix of fine-grained and coarse-grained material that is between 80% and 90% sand and is therefore not suitable for beach placement. This material is suitable, however, for disposal in Brandt Island or in the ODMDS. At this time, based on comments received on the Draft DMMP, there are no plans to place this dredged material in the nearshore placement areas. The viable alternatives for disposal of material from the West Leg 2 and North Range C are listed below in Table 3-14.

ID #	Disposal Area	Dredging Method	Average Annual Cost
IH-12	Brandt Island	18” Pipeline	$359,000
IH-13	ODMDS	Bucket & Barge	$534,900

Table 3-14. Costs for Disposal from West Leg 2 & N. Range C

As shown in Table 3-14, the least cost dredging method is by 18-inch pipeline with disposal in Brandt Island at an average cost per cycle of about $359,000. The next most cost effective measure would have been to dispose of this material in the nearshore placement areas, via bucket and barge, at an average annual cost of approximately $526,000; however, the most feasible option is to combine this reach with the other Inner Harbor reaches and to use an 18-inch pipeline dredge with disposal in Brandt Island. Use of the ODMDS for this material is also an option as it would prolong the life of Brandt Island, but it is not the least cost option.

Brandt Island Dike Raises and Expansion. Portions of Brandt Island contain fine-grained material that is not suitable for beach disposal. As a result of the lack of consistently coarse-grained material in Brandt Island, future plans are to dispose of fine-grained material (only) there. Brandt Island is the least-cost alternative for all of the Inner Harbor reaches. Prior to Brandt Island reaching capacity in 2028, the costs of expanding and raising the dikes to create additional capacity would be compared to the costs of alternative disposal methods, such as disposal in the ODMDS. This would add flexibility to the Harbor maintenance alternatives, which could save costs during future dredging events. Table 3-15 below shows costs for creating additional capacity in Brandt Island by expanding and raising the dike. The DMMP does not propose to raise or expand the Brandt Island dike at this time, but recommends investigating that option as Brandt Island reaches capacity. Implementation of the DMMP is funding-dependent and future funding cannot be predicted, therefore, the likelihood of having adequate funding for future projects, such as a Brandt Island dike raise, is unknown.

Elevation	Capacity Gained (cy)	Total Cost
42 FT	1,690,723	$2,916,600
47 FT	2,506,497	$4,180,300
52 FT	3,300,624	$5,711,200
55 FT	3,771,856	$6,718,500

Table 3-15. Costs & Capacity Gained by Expanding & Raising Brandt Island Dike

3.3.2.2 Beach Placement

Disposal of Material from South Range C and North Range B. Material from South Range C and North Range B is coarse-grained material (greater than or equal to 90% sand) that should be kept in the littoral system by placement on the beach or in the Nearshore West or East. Although this reach contains material comparable to that found in South Range B, the Cutoff and Range A out to Station 110+00, early in the planning process, this reach was separated from those reaches in order to evaluate the placement of this material in the nearshore areas in water depths of 25 feet or less (shallow). Table 3-16 provides average annual costs for the potentially viable alternatives considered for disposal of material from South Range C and North Range B. This coarse-grained material could also be placed on the beaches of Fort Macon State Park and Atlantic Beach by 30-inch pipeline dredge at an average annual cost ranging from about $1,116,000 to $1,465,000. This dredged material could also be placed on Shackleford Banks; however following review of the draft DMMP, the NPS requested that no dredged material be placed on Shackleford Banks. The least cost method of disposal is use of a hopper dredge with placement of material in the nearshore placement areas. The most cost-effective means to handle this material is to combine maintenance of this reach with South Range B, the Cutoff and Range A out to

Station 110+00, reaches that require an ocean certified pipeline dredge. As another option, but at higher costs, this coarse-grained material could be handled with an 18-inch pipeline dredge inside the COLREGS line. COLREGS refers to the 1972 International Regulations for Preventing Collisions at Sea and COLREGS Lines of Demarcation were established by the Coast Guard to designate where "International Rules of the Road" of navigation separate from "U.S. Inland Rules". An 18-inch dredge must work inside the COLREGS line, whereas a 30-inch dredge is "ocean certified" and may also work outside the line in the Atlantic Ocean.

ID #	Disposal Area	Dredging Method	Average Annual Cost
OH-5 or OH-7a	Nearshore West (Existing) or East	Hopper	$730,800
OH-5a	Nearshore West (Expanded)	Hopper	$773,000
OH-7 or OH-5b	Nearshore West/East (Shallow)	Hopper	$863,200
OH-4 or OH-6a	Nearshore West (Existing) or East	Bucket & Barge	$1,090,200
OH-4a	Nearshore West (Expanded)	Bucket & Barge	$1,097,400
OH-9	Beach Disposal (Bogue Banks)	30" Pipeline	$1,116,500
OH-6 or OH-4b	Nearshore West/East (Shallow)	Bucket & Barge	$1,145,400
OH-9a or OH-11a	Nearshore West/East	30" Pipeline	$1,464,900
OH-8	Beach Disposal (Bogue Banks)	18" Pipeline	$1,822,800
OH-11b	Nearshore West /East	18" Pipeline	$2,250,500

Table 3-16. Costs for Disposal of Material from South Range C and North Range B

Disposal of Material from South Range B, the Cutoff and Range A out to Station 110+00. Material in this Range is coarse-grained material (greater than or equal to 90% sand) that may be placed on the beach or in the Nearshore West or East. Table 3-17 provides the average cost per cycle for the alternatives that could potentially draw material from this area. This portion of the Harbor requires dredging on an annual basis. Because of the increased frequency of dredging, the cost per cubic yard increases with annual activity. Typically this material has been placed on the beach during the first year of the 3-year maintenance cycle and in the Nearshore West in years 2 and 3 of the cycle. Under the assumption that this practice will continue (with the addition of use of the Nearshore East), the least cost option would be to use a hopper dredge with placement of material in the Nearshore West and/or East, every second and third year. Placement of this material on the beaches of Fort Macon State Park and

Atlantic Beach by 30-inch pipeline dredge would incur an average annual cost of approximately $14,408,000. Although this cost is relatively high, the placement of dredged material on the beaches would offset potential impacts to the adjacent beaches (a function previously performed on Bogue Banks by recycling sand from Brandt Island). Additionally, the Cutoff section of the channel, with its steep bank heights and high concentrations of material, cannot always be efficiently dredged with a hopper. In this area, with extreme bank height combined with swift cross currents, hopper dredges are at risk of damaging drag heads, and would often resort to the use of only one drag head when dredging, making the operation much less efficient. This reduction in efficiency would potentially lead to the need to bring in two hopper dredges in order to complete the job in the 90-day dredging window that the District has used. Therefore, while typically the least cost disposal option for the entire area is use of a hopper dredge with placement in the nearshore placement areas, the chronic, steep shoaling in the Cutoff makes periodic pipeline dredging an essential part of the least cost plan. The average annual cost of this option ranges from about $4,879,000 to $5,783,000. A bucket and barge could also be used in this area, but at higher costs. Another measure that may be considered for beach placement is a hopper pumpout.

ID #	Disposal Area	Dredging Method	Average Annual Cost
OH-16 or OH-18a	Nearshore West (Existing) or East	Hopper	$4,879,200
OH-16a	Nearshore West (Expanded)	Hopper	$5, 191,800
OH-16b or OH-18	Nearshore West/East (Shallow)	Hopper	$5, 783,500
OH-15 or OH-17a	Nearshore West (Existing) or East	Bucket & Barge	$8, 775,900
OH-15a	Nearshore West (Expanded)	Bucket & Barge	$9,032,700
OH-15b or OH-17	Nearshore West/East (Shallow)	Bucket & Barge	$9,847,700
OH-19 or OH-21	Beach Placement (Bogue Banks)	30” Pipeline	$14,408,400
OH-19a or OH-21a	Nearshore West/East	30” Pipeline	$15,768,800
OH-20 or OH-22	Beach Placement (Bogue Banks)	Hopper Pumpout	$12, 533,600

Table 3-17. Costs for Disposal of Material from South Range B, Cutoff, North Range A out to Station 110+00

3.3.2.3 Ocean Dredged Material Disposal

Disposal of Material from Range A seaward of Station 110+00. Material from Range A seaward of station 110+00 is fine-grained material that is in close proximity to the ODMDS and as such, should be disposed of in the ODMDS. Table 3-18 provides average annual costs of the alternatives which could potentially draw material from South Range A seaward of Station 110+00. The least cost option is by hopper dredge at an average annual cost of about $620,000. Hopper dredges are even more cost effective when ranges are combined into a single contract. Technically, material from anywhere in the Harbor could be disposed of in the ODMDS, with fine-grained and coarse-grained material segregated to allow efficient removal of material for future beach disposal.

ID #	Disposal Area	Dredging Method	Average Annual Cost
OEC3	ODMDS from 110+00 Outward	Hopper	$620,400
OEC2	ODMDS from 110+00 Outward	Bucket & Barge	$1,033,100

Table 3-18. Costs for Disposal of Material from South Range A Seaward of Station110+00

3.3.2.4 Ebb Tide Delta Placement

Disposal of Material from South Range C and North Range B. Material from South Range C and North Range B is coarse-grained (greater than or equal to 90% sand) that could be placed in the nearshore placement areas or on the adjacent beaches. Table 3-16, above, provides average annual costs for the potentially viable alternatives considered for disposal of material from South Range C and North Range B. The least cost method of disposal is by use of a hopper dredge with placement of material in the nearshore placement areas. Depending on the exact placement location, average annual costs range from about $730,000 to $863,000. This material may also be placed in the existing nearshore placement areas by bucket and barge with annual costs ranging from about $1,100,000 to $1,150,000. This placement of material within the ebb tide delta would help reduce sediment losses in the ebb tide delta.

Disposal of Material from South Range B, the Cutoff and Range A out to Station 110+00. Material from Range B, the Cutoff and Range A out to Station 110+00 is coarse-grained material (greater than or equal to 90% sand) that may also be placed in the ebb tide delta or on the adjacent beaches. Table 3-17, above, provides the average annual costs for the measures considered for South Range B, the Cutoff and Range A out to Station 110+00. The least cost disposal option for this material is use of a hopper dredge with placement in the nearshore placement areas (ebb tide delta). Depending on the placement location within the ebb tide delta, average annual costs range from about $4,879,000 to $5,783,000. A bucket and barge could also be used in this area for ebb tide delta placement, but at higher costs. The Nearshore West continues to fill, such that much (and potentially all) of the existing Nearshore Area is too shallow for hopper dredges or fully-laden scows to safely operate. A more effective method of placing material in the Nearshore West Placement Area, particularly at depths of less than 25 feet, would be a direct pipeline. This method would involve an ocean-certified cutterhead pipeline dredge working in sandy areas of the channel (where sand content exceeds 90%), with its pipeline running directly to the nearshore area. The pipeline would likely be submerged as it crossed the navigation channel, but would then transition to a floating line to avoid potential cultural resources in the vicinity of the nearshore placement area. Any necessary anchoring of the pipeline would only be accomplished in areas surveyed and found to be clear of all cultural resources. The pipeline would terminate on a barge or similar floating platform under the control of tugboats, and would then be slowly moved during discharge to avoid mounding of material. The pipe would either be equipped with a diffuser at or near the water surface, and/or equipped with a short downspout for discharge just below the water surface. It should be noted that costs in Table 3-17 for pipeline to the nearshore assume that both nearshore areas would be used during each dredging event. Due to funding limitations, if pipeline to the nearshore is used, it’s likely that only one nearshore area would be used during a single dredging event, resulting in a cost that is lower than the cost shown in Table 3-17. The other measure recommended as part of the base plan is placement of this material on the adjacent beaches, as discussed above.

3.3.3 Summary of Least Cost Analysis

The DMMP assumes that the navigation channel will be maintained to the fully authorized dimensions. The proposed disposal plan provides for placement of coarse-grained material (greater than or equal to 90% sand) on the beaches of Fort Macon State Park and Atlantic Beach every three years, with fine-grained material being disposed of in Brandt Island or the ODMDS. As shown in Table 3-19, this plan would have an average annual cost of $13,662,000 (October 2014 price levels).

Calendar Year	Project Year		Annual Cost	Present Value
2016	1		$18,839,800	$18,840,000
2017	2		$7,827,000	$7,571,000
2018	3		$12,219,900	$11,435,000
2019	4		$18,839,800	$17,054,000
2020	5		$7,827,000	$6,854,000
2021	6		$12,219,900	$10,351,000
2022	7		$18,839,800	$15,438,000
2023	8		$7,827,000	$6,204,000
2024	9		$12,219,900	$9,370,000
2025	10		$18,839,800	$13,975,000
2026	11		$7,827,000	$5,616,000
2027	12		$12,219,900	$8,482,000
2028	13		$18,839,800	$12,650,000
2029	14		$7,827,000	$5,084,000
2030	15		$14,101,200	$8,860,000
2031	16		$18,839,800	$11,451,000
2032	17		$7,827,000	$4,602,000
2033	18		$14,101,200	$8,020,000
2034	19		$18,839,800	$10,366,000
2035	20		$7,827,000	$4,166,000
	Total Cost			$196,389,000
	Average Annual Cost			$13,662,000

Table 3-19. DMMP Average Annual Costs

A summary of the least cost analysis is shown in Tables 3-19 and 3-20 below. As presented in Table 3-20, the maintenance dredging costs can be divided by areas and projected by year using historic dredging records and future expectations. Costs to maintain Morehead City Harbor are increasing, principally because the costs to manage Brandt Island and to place material on adjacent beaches are higher than historic costs. Also, the DMMP anticipates dredging about 1.3 million cubic yards of material each year, higher than the historic amount of approximately 1 million cubic yards per year. By estimating the costs of this larger volume of material, expected costs are higher than historic costs.

The expected average annual cost to implement the DMMP for the operation and maintenance of Morehead City Harbor is given in the table below. These costs are in Fiscal year 2011 price level (January 2011) at an interest rate of 4.000% for a twenty year period from 2016 through 2035 and do not contain costs for Planning, Engineering and Design (PED), monitoring, or Supervisory and Administrative (S&A) costs. Table 3-

21 provides a more detailed cost summary of the 20-year plan, including Monitoring, PED and S & A costs.

Year of 3-yr cycle	Disposal Location	Average Cost per Cycle
1	Beaches	$18,839,800
2	Nearshore East and West	$7,827,000
3	Brandt Island (2016-2028)	$3,568,800
3	Nearshore East and West	$5,125,100
3	ODMDS	$2,192,000
3	ODMDS (2029-2035 (after Brandt Island is full))	$5,489,900

Table 3-20. Summary of Average Cost by Disposal/Placement Location

Year	Brandt Island	Nearshore East and West	Beaches	ODMDS	Monitoring PED, S&A	Total Cost	Present Value
2016			$17,589,500		$1,250,300	$18,839,800	$18,840,000
2017		$6,842,100			$984,900	$7,827,000	$7,571,000
2018	$3,568,800	$5,125,100		$2,192,000	$1,334,000	$12,219,900	$11,435,000
2019			$17,589,500		$1,250,300	$18,839,800	$17,054,000
2020		$5,903,700			$894,500	$7,827,000	$6,854,000
2021	$3,568,800	$5,125,100		$2,192,000	$1,334,000	$12,219,900	$10,351,000
2022			$17,589,500		$1,250,300	$18,839,800	$15,438,000
2023		$5,903,700			$894,500	$7,827,000	$6,204,000
2024	$3,568,800	$5,125,100		$2,192,000	$1,334,000	$12,219,900	$9,370,000
2025			$17,589,500		$1,250,300	$18,839,800	$13,975,000
2026		$5,903,700			$894,500	$7,827,000	$5,616,000
2027	$3,568,800	$5,125,100		$2,192,000	$1,334,000	$12,219,900	$8,482,000
2028			$17,589,500		$1,250,300	$18,839,800	$12,650,000
2029		$6,842,100			$984,900	$7,827,000	$5,084,000
2030		$5,125,100		$7,681,900	$1,294,200	$14,101,200	$8,860,000
2031			$17,589,500		$1,250,300	$18,839,800	$11,451,000
2032		$6,842,100			$984,900	$7,827,000	$4,602,000
2033		$5,125,100		$7,681,874	$1,294,200	$14,101,200	$8,020,000
2034			$17,589,500		$1,250,300	$18,839,800	$10,366,000
2035		$6,842,100			$984,900	$7,827,000	$4,166,000
Total Costs	$14,275,308	$75,830,200	$123,126,500	$24,131,828	$23,299,600		$196,389,000
					Average Annual Cost		**$13,662,000**

Table 3-21. Year-by-Year Cost Summary of the Proposed Base Plan

The Harbor at Morehead City is compact and includes about three miles of interior channels from the Port facility to Beaufort Inlet and about four miles from the Inlet out to naturally deep water in the open ocean. Due to the relatively short distances covered by the Morehead City Harbor navigation channel, dredging equipment working in one range of the Harbor may cost effectively work in other ranges, even if it does not appear to be least cost. Since mobilization costs are very high, equipment that can be mobilized for multiple ranges is very advantageous. Also, mobilization of equipment for Morehead City Harbor may be done in conjunction with Wilmington Harbor or the Atlantic Intracoastal Waterway (AIWW) to further reduce costs to each project. The proposed DMMP, which is described in detail below, attempts to provide flexibility and interoperability thus allowing innovative proposals to accomplish the maintenance dredging at the least possible cost while minimizing impacts of the navigation project.

3.4 Proposed Base Plan (DMMP)

The sections below provide a summary of the process used to analyze and screen alternatives (Trade-Off Analysis), a detailed description of the proposed 20-year base plan, and real estate requirements associated with the base plan.

3.4.1 Trade-Off Analysis

The recommended base plan for the Morehead City Harbor DMMP was developed through a plan formulation process that incorporated knowledge gained over the past several decades of maintaining the Morehead City Harbor navigation channels. Specifically, development of the recommended base plan was based on dredging methods and costs, disposal options, sediment quality data, analysis of the physical and natural environment within the study area, and coordination with stakeholders and resource agencies. As presented in Tables 3-20 thru 3-24, below, a variation of the direct scoring method, also called the “Borda” method (Pomerol and Barba-Romero 2000), was used to inform the process of selecting the base plan. Tables 3-20 thru 3-24 demonstrate the trade-offs considered in the development of the base plan for the DMMP. For each DMMP measure evaluated, trade-offs with respect to five criteria were considered. The five criteria are dredged material disposal/placement capacity, environmental acceptability, operational viability, beneficial uses, and cost. Rankings of various criteria were summed for all measures considered in the development of the base plan. Scores were assigned for each criterion ranging from 1 (worst) to 5 (best), as described below.

Disposal or Placement Capacity. Each DMMP measure was evaluated for the dredged material disposal or placement capacity that it provides over the life of the DMMP (20 years). The ranking below does not identify specific dredged material quantities for each rank because required capacities vary widely within the various sections of the Morehead City Harbor navigation project. Also, dredged material disposal sites such as the 8-square mile ODMDS and local beaches have virtually unlimited capacity.

5 – Site has capacity beyond the 20-year life of the DMMP
4 – Site has capacity sufficient for at least the next 20 years
3 – Site has capacity sufficient for at least the next 10 years
2 – Site provides slightly greater capacity than that required for one dredging event
1 – Site does not provide sufficient capacity for one dredging event

Environmental Acceptability. This criterion considers the environmental acceptability of a measure being evaluated and includes consideration of regulatory or permitting issues and views by resource agencies.

5 – No environmental issues regarding this option exist and/or site is already permitted for disposal or placement of dredged material
4 – Site is not currently approved for disposal or placement of material, however, obtaining approval from resource agencies is not likely an issue
3 – Some resource agencies may favor this option while others may not and/or site is not currently approved for disposal or placement of dredged material however, obtaining approval should not prove difficult
2 – Some resource agencies may favor this option while others would not and/or site is not currently approved for disposal or placement of dredged material and obtaining approval would prove difficult
1 – Resource agencies are strongly opposed to this option and/or site is not approved for disposal/placement of dredged material and likely would not be in the future

Operational Viability. This criterion evaluates the operational viability of the various measures considered by taking into account the type of dredge plant used within the various ranges of the Harbor and the characteristics of the material being dredged.

5- This is the preferred mode of operation
4- This is not the preferred mode of operation, but is operationally feasible
3- This is not the preferred mode of operation and is marginal operationally
2- This is not the preferred mode of operation and is not operationally feasible
1- This option is not operationally possible

Beneficial Uses. Each DMMP measure was evaluated based on its level of beneficial use. This criterion considered the beneficial uses associated with reducing impacts of the navigation project on adjacent beaches and the ebb tide delta. This criterion also takes into account potential beneficial uses for environmental purposes including fish and wildlife habitat creation, ecosystem restoration and enhancement, and coastal storm damage reduction.

5 – Beneficial use that successfully offsets potential impacts from the navigation project (beaches and ebb tide delta).
4 – Beneficial use that reduces potential impacts from the navigation project (beaches and ebb tide delta), but to a lesser degree than those rated 5.

3 – Beneficial use that does not reduce impacts from the navigation channel, but which has the potential to provide wildlife habitat and ecosystem restoration and/or enhancement
2 – Marginal beneficial use
1 – Not a beneficial use

Cost. This criterion considers the relative average annual costs of the measures considered. Costs are simply in rank order with a rank of 5 being the least cost measure and other costs ranked relative to the least cost as follows.
5 – Least cost
4 – Next highest cost relative to least cost
3 – Next highest cost relative to measures ranked as 4
2 – Next highest cost relative to measures ranked as 3
1 – Highest cost

The following pages include the summary of the trade-off analysis for DMMP measures considered during development of the recommended base plan. Each of the tables below addresses a particular channel range within the Harbor. Channel ranges were identified based on their location within the Harbor and the sediment characteristics of material typically dredged from those areas. All five screening criteria were considered for every potential measure evaluated, however, measures that received a score of 1 for disposal capacity, environmental acceptability, or operational viability were eliminated from further consideration and costs were not computed for the majority of those particular measures. In some cases, costs were computed only for comparison purposes. As shown in Tables 3-20 thru 3-24, although several options are available for some of the Harbor ranges, the recommended base plan includes only those measures highlighted in blue. Considering all trade-offs, these measures provide the best balance between least cost, sound engineering, and environmental acceptability. The intent of the DMMP is to remain flexible, therefore, any of the high ranking measures could be implemented in the future. However, costs for the 20-year plan were based on those measures highlighted in blue. Following each table is an explanation of the logic used in selecting the recommended base plan.

Inner Harbor (IH) - Northwest Leg, West Leg 1 and East Leg - sediments < 80% sand									
Measure ID#	Dredging Method	Disposal/Placement Area	Disposal or Placement Capacity (1-5)	Environmental Acceptability (1-5)	Operational Viability (1-5)	Beneficial Use (1-5)	Cost (1-5)	Excluded	Total Score
IH-1	18-inch pipeline	Brandt Island	3	5	5	1	5		19
IH-2	bucket & barge	ODMDS	5	5	5	1	4		20
IH-3	hopper	ODMDS	5	5	1	1		X	
IH-4	bucket & barge	Nearshore West	4	1	1	4		X	
IH-5	hopper	Nearshore West	4	1	1	4		X	
IH-6	bucket & barge	Nearshore East	4	1	5	4		X	
IH-7	hopper	Nearshore East	4	1	1	4		X	
IH-8	18-inch pipeline	Ft. Macon / Atlantic Beach	5	1	4	1		X	
IH-9	30-inch pipeline	Ft. Macon / Atlantic Beach	5	1	4	1		X	
IH-10	18-inch pipeline	Shackleford Banks Beach	5	1	4	1		X	
IH-11	30-inch pipeline	Shackleford Banks Beach	5	1	4	1		X	
IH-A	18-inch pipeline	Marsh Island or Radio Island	1	5	5	1		X	
IH-B	varies	Modify Environmental Windows	NA	3	5	NA			8
IH-C	18-inch pipeline	Construct Waterbird Islands	2	2	1	1		X	
IH-D	18-inch pipeline	Create Wetlands	1	3	3	3	3		13
IH-E	varies	Construct New Upland Disposal Site	1	4	4	1		X	
IH-F	varies	Brandt Island Shoreline Stabilization	NA	3	NA	2		X	

Measure	Reason(s) For Elimination
IH-3, IH-5, IH-7	Use of a hopper dredge in the Inner Harbor is not operationally viable
IH-4 thru IH-7	Not preferable to place fine-grained material in the nearshore
IH-8 thru IH-11	Sediments not suitable for beach placement
IH-A and IH-D	Does not provide enough capacity for a single dredging event
IH-C	- Fine-grained material not suitable habitat for waterbird nesting - Constructing an island with fine-grained material is not operationally viable
IH-E	No undeveloped uplands exist in the project vicinity
IH-F	An analysis was performed to determine if stabilizing the north shoreline of Brandt Island would decrease shoaling within the Harbor (Section 3.2.6.11). Due to the limited change observed during this analysis, a shoreline stabilization measure was not evaluated further.
IH-G	Current commercial/military navigation traffic requires the full channel dimensions.

Table 3-22. Screening of Measures for Maintenance of the Northwest Leg/West Leg 1 & East Leg (sediments less than 80% sand)

As shown in Table 3-22, measures IH-1 and IH-2 are the only feasible options for disposal of material from the Northwest Leg, West Leg 1 and the East Leg. Due to the fine-grained nature of these sediments, disposal options are limited to Brandt Island (IH-1) and the ODMDS (IH-2).

The Brandt Island pipeline dredge option (IH-1) costs less than mechanical dredging with disposal in the ODMDS. Besides being the least cost option for this material, dredging contracts for the Morehead City Harbor project are usually grouped with contracts for maintenance dredging of the AIWW (pipeline dredging), resulting in cost savings for both projects. This cost savings is quite variable and therefore was not included in the cost calculations for the IH-1 alternative, but would further reduce the cost of Brandt Island disposal. The Brandt Island capacity is much more limited than the ODMDS, resulting in a lower capacity score for Brandt Island. Based on the trade-off analysis, the recommended plan for maintenance of the fine-grained material in the Inner Harbor is use of an 18-inch pipeline with disposal in Brandt Island until it reaches capacity in 2028. As Brandt Island nears capacity, the District will evaluate the option of dike expansion and dike raises as compared to the costs of taking this Inner Harbor material to the ODMDS.

Inner Harbor (IH) - West Leg 2 & North Range C - sediments at least 80% sand									
Measure ID#	Dredging Method	Disposal/Placement Area	Disposal or Placement Capacity (1-5)	Environmental Acceptability (1-5)	Operational Viability (1-5)	Beneficial Use (1-5)	Cost (1-5)	Excluded	Total Score
IH-12	18-inch pipeline	Brandt Island	4	5	5	1	5		20
IH-13	bucket & barge	ODMDS	5	5	4	1	3		18
IH-14	Hopper	ODMDS	5	5	1	1		X	
IH-15	bucket & barge	Nearshore West-shallow	4	2	4	5	3	X	18
IH-15a	bucket & barge	Nearshore West- expanded	4	2	4	4	4	X	18
IH-15b	bucket & barge	Nearshore West- existing	4	2	4	4	4	X	18
IH-16	Hopper	Nearshore West -shallow	4	2	1	5		X	
IH-16a	Hopper	Nearshore West -expanded	4	2	1	4		X	
IH-16b	Hopper	Nearshore West -existing	4	2	1	4		X	
IH-17	bucket & barge	Nearshore East- shallow	4	2	5	5	3	X	19
IH-17a	bucket & barge	Nearshore East	4	2	5	4	4	X	19
IH-18	Hopper	Nearshore East - shallow	4	2	1	5		X	
IH-18a	Hopper	Nearshore East	4	2	1	4		X	
IH-19	18-inch pipeline	Ft. Macon / Atlantic Beach	5	1	4	1		X	
IH-20	30-inch pipeline	Ft. Macon / Atlantic Beach	5	1	5	1		X	
IH-21	18-inch pipeline	Shackleford Banks Beach	5	1	4	1		X	
IH-22	30-inch pipeline	Shackleford Banks Beach	5	1	5	1		X	
IH-23	30-inch Pipeline	Nearshore West	4	2	5	4	3	X	18
IH-24	30-inch Pipeline	Nearshore East	4	2	5	4	3	X	18
IH-25	18-inch Pipeline	Nearshore West or East	4	2	5	4	2	X	17
IH-A	18-inch pipeline	Marsh Island or Radio Island	1	5	5	1		X	
IH-B	varies	Modify Environmental Windows	NA	3	5	NA			8
IH-C	18-inch Pipeline	Construct Waterbird Islands	2	2	1	3	1		9
IH-D	18-inch Pipeline	Create Wetlands	1	4	3	4		X	
IH-E	varies	Construct New Upland Disposal Site	1	4	4	1		X	
IH-F	varies	Brandt Island Shoreline Stabilization	NA	3	NA	2		X	
IH-G	varies	Reduce Channel Dimensions	NA	5	1	NA		X	

Measure	Reason(s) Measure Eliminated
IH-14, IH-16, 16a,16b, IH-18 and 18a	Use of hopper dredge in Inner Harbor not operationally feasible
IH-15, 15a, 15b, 17, 17a, 23, 24, and 25	Placement of 80% sand in nearshore areas eliminated due to NMFS concerns (turbidity)
IH-19 thru IH-22	Sediments not suitable for beach placement
IH-A, IH-C and IH-D	Does not provide enough capacity for a single dredging event
IH-E	No undeveloped uplands exist in the project vicinity
IH-F	An analysis was performed to determine if stabilizing the north shoreline of Brandt Island would decrease shoaling within the Harbor. Due to the limited change observed during this analysis, a shoreline stabilization measure was not evaluated further.
IH-G	Current commercial/military navigation traffic requires the full channel dimensions

Table 3-23. Screening of Measures for Maintenance of the West Leg 2 & N. Range C.

The West Leg 2 and North Range C contain sediments that are between 80% and 90% sand. As shown in Table 3-23, these sediments may be disposed of in Brandt Island (IH-12) or the ODMDS (IH-13). Use of the nearshore placement areas (H-15, 15a, 15b, 17, 17a, 23, 24, and 25) for this material was eliminated based on comments received from NMFS. The most cost-effective alternative that is environmentally acceptable and operationally feasible is use of an 18-inch pipeline dredge with disposal in Brandt Island. However, use of a pipeline dredge with a spider barge, bucket and barge, and/or direct placement by pipeline dredge in the nearshore are potential options. The nearshore placement areas provide the only potential for beneficial use of this material by keeping the dredged material “in the system,” however, in addition to resource agency concerns, it is inefficient to mobilize a separate dredge (bucket and barge) for the small amount of material in this range - about 152,000 cubic yards every three years. It is much more efficient to combine this reach with the other Inner Harbor reaches and to use a pipeline dredge with disposal in Brandt Island. Therefore, for the West Leg 2 and North Range C, the recommended base plan is use of an 18-inch pipeline dredge with disposal in Brandt Island until it reaches capacity in 2028. As Brandt Island nears capacity, the District will reevaluate the option of taking this material to the nearshore placement areas, expanding and raising the Brandt Island dike, or disposing of this material in the ODMDS.

Outer Harbor (OH) - South Range C & North Range B - sediments ≥ 90% sand									
Measure ID#	Dredging Method	Disposal/Placement Area	Disposal or Placement Capacity (1-5)	Environmental Acceptability (1-5)	Operational Viability (1-5)	Beneficial Use (1-5)	Cost (1-5)	Excluded	Total Score
OH-1	18-inch Pipeline	Brandt Island	2	1	5	1		X	
OH-2	Bucket & Barge	ODMDS	5	4	5	1		X	
OH-3	Hopper	ODMDS	5	4	5	1		X	
OH-4	Bucket & Barge	Nearshore West (existing)	3	5	5	4	4		21
OH-4a	Bucket & Barge	Nearshore West (expanded)	4	5	5	4	4		22
OH-4b	Bucket & Barge	Nearshore West (expanded shallow)	4	5	4	5	4		22
OH-5	hopper	Nearshore West (existing)	4	5	5	4	5		23
OH-5a	hopper	Nearshore West (expanded)	4	4	5	4	5		22
OH-5b	hopper	Nearshore West (expanded shallow)	4	4	4	5	5		22
OH-6	Bucket & Barge	Nearshore East (shallow)	3	4	4	5	4		20
OH-6a	Bucket & Barge	Nearshore East	4	4	5	4	4		21
OH-7	Hopper	Nearshore East (shallow)	4	4	4	5	5		22
OH-7a	Hopper	Nearshore East	4	4	5	4	5		22
OH-8	18-inch pipeline	Ft. Macon / Atlantic Beach	5	5	4	5	2		21
OH-9	30-inch pipeline	Ft. Macon / Atlantic Beach	5	5	5	5	4		24
OH-9a	30-inch Pipeline	Nearshore West (anywhere)	5	4	5	4	3		21
OH-10	18-inch pipeline	Shackleford Banks Beach	5	4	4	5	2	X	20
OH-11	30-inch pipeline	Shackleford Banks Beach	5	4	5	5	4	X	23
OH-11a	30-inch Pipeline	Nearshore East	5	4	5	4	3		21
OH-11b	18-inch Pipeline	Nearshore East or West	5	4	5	4	2		20
OH-A	18-inch pipeline	Marsh Island or Radio Island	1	1	5	2		X	
OH-B	Varies	Modify Environmental Windows	NA	3	5	NA			8
OH-C	18-inch pipeline	Construct Waterbird Islands	2	3	4	3	1		13
OH-D	18-inch pipeline	Create Wetlands	1	2	3	2		X	
OH-E	varies	Construct New Upland Disposal Site	1	4	4	1		X	
OH-F	varies	Brandt Island Shoreline Stabilization	NA	3	NA	2		X	
OH-G	varies	Reduce Channel Dimensions	NA	5	1	NA		X	

Measure	Reason(s) Measure Eliminated
OH-1, OH-2 and OH-3	Removes coarse-grained sediments(≥90% sand) from littoral system
OH-10 and OH-11	Recommended by USACE but declined by NPS
OH-A, OH-C and OH-D	Does not provide enough capacity for a single dredging event
OH-E	- No undeveloped uplands exist in the project vicinity - Removes coarse-grained sediments(≥90% sand) from littoral system
OH-F	An analysis was performed to determine if stabilizing the north shoreline of Brandt Island would decrease shoaling within the Harbor. Due to the limited change observed during this analysis, a shoreline stabilization measure was not evaluated further.
OH-G	Current commercial navigation traffic requires the full channel dimensions

Table 3-24. Screening of Measures for Maintenance of South Range C and North Range B.

As shown in Table 3-24, there are several potentially viable options for the disposal of coarse-grained sediments (≥90% sand) from South Range C and North Range B. For these measures, capacity, environmental acceptability and operational viability varied very little. The determining screening criteria were beneficial use and cost. All of the potential options beneficially use the dredged material, however, those options that would result in material being placed directly on the beach or in the active littoral zone (Nearshore West shallow) received the highest scores. Trade-offs are comparable between use of a mechanical dredge with placement in either Nearshore Placement Area (OH-4, 4a, 4b and OH-6) and use of a 30-inch pipeline dredge with placement of material on the beaches of Fort Macon State Park and Atlantic Beach (OH-9) or on Shackleford Banks (OH-11), therefore all of the measures highlighted in blue are viable and are included on a rotational basis in the proposed base plan. Although placement of dredged material on Shackleford Banks is recommended, this measure is not highlighted in blue because the NPS has requested that no dredged material be placed on Shackleford Banks. Also, as described in Section 3.3.2.4, another potential option that may be exercised in the near future is use of a pipeline dredge with placement in the Nearshore Areas. In year 1 of the 3-year cycle, material from this range will be placed on the beaches of Fort Macon and Atlantic Beach and in years 2 and 3, material will be placed in the nearshore placement areas.

Outer Harbor (OH) - South Range B , Cutoff, North Range A to sta. 110+00 - sediments ≥ 90% sand

Measure ID#	Dredging Method	Disposal/Placement Area	Disposal or Placement Capacity (1-5)	Environmental Acceptability (1-5)	Operational Viability (1-5)	Beneficial Use (1-5)	Cost (1-5)	Excluded	Total Score
OH-12	18-inch Pipeline	Brandt Island	2	1	4	1		X	
OH-13	Bucket & Barge	ODMDS	5	4	2	1	4		16
OH-14	Hopper	ODMDS	5	4	5	1	5		20
OH-15	Bucket & Barge	Nearshore West-Existing	4	5	2	4	4	X	19
OH-15a	Bucket & Barge	Nearshore West-expanded	4	5	2	4	4	X	19
OH-15b	Bucket & Barge	Nearshore West-shallow	4	5	2	5	3	X	19
OH-16	hopper	Nearshore West (existing)	4	5	5	4	5		23
OH-16a	hopper	Nearshore West (expanded)	4	5	5	4	5		23
OH-16b	hopper	Nearshore West (expanded shallow)	4	5	4	5	5		23
OH-17	Bucket & Barge	Nearshore East-shallow	4	4	2	5	3	X	18
OH-17a	Bucket & Barge	Nearshore East	4	4	2	4	4	X	18
OH-18	Hopper	Nearshore East-shallow	4	4	4	5	5		22
OH-18a	Hopper	Nearshore East	4	5	5	4	5		23
OH-19	30-inch pipeline	Ft. Macon / Atlantic Beach	5	5	5	5	4		24
OH-19a	30-inch Pipeline	Nearshore West	4	4	5	4	2		19
OH-20	Hopper (pump-out)	Ft. Macon / Atlantic Beach	5	5	4	5	1		20
OH-21	30-inch Pipeline	Shackleford Banks Beach	5	2	5	5	4	X	21
OH-21a	30-inch Pipeline	Nearshore East	4	4	5	4	2		19
OH-22	Hopper (pump-out)	Shackleford Banks Beach	5	2	4	5	1	X	17
OH-A	30-inch pipeline	Brandt Island	2	5	4	1		X	
OH-B	30-inch pipeline	Marsh Island or Radio Island	1	5	2	1		X	
OH-C	varies	Modify Environmental Windows	NA	3	5	NA			8
OH-D	30-inch pipeline	Construct Waterbird Islands	1	3	4	3		X	
OH-E	30-inch pipeline	Create Wetlands	1	2	3	2		X	
OH-F	varies	Construct New Upland Disposal Site	1	4	4	1		X	
OH-G	varies	Brandt Island Shoreline Stabilization	NA	3	NA	2		X	
OH-H	varies	Reduce Channel Dimensions	NA	5	1	NA		X	

Measure	Reason(s) Measure Eliminated
OH-12, OH-13 and A	Removes coarse-grained sediments(≥90% sand) from littoral system
OH-13, OH-15/ 15a/15b, OH-17/17b	Operationally not viable (mechanical dredge with scow in open ocean)
OH-14	Removes coarse-grained sediments(≥90% sand) from littoral system
OH-21 and OH-22	Recommended by USACE but declined by NPS
OH-B, OH-D, OH-E	Does not provide enough capacity for a single dredging event
OH-F	No undeveloped uplands exist in the project vicinity
OH-G	An analysis was performed to determine if stabilizing the north shoreline of Brandt Island would decrease shoaling within the Harbor. Due to the limited change observed during this analysis, a shoreline stabilization measure was not evaluated further.
OH-H	Current commercial navigation traffic requires the full channel dimensions

Table 3-25. Screening of Measures for Maintenance of South Range B, Cutoff, North Range A to Station 110+00

South Range B, the Cutoff, and North Range A out to Station 110+00 contain coarse-grained sediments (greater than or equal to 90% sand) that may be beneficially used in either of the nearshore placement areas or on the beaches of Fort Macon State Park, Atlantic Beach or Shackleford Banks (currently not an approved placement location as determined by NPS). As shown in Table 3-25, there are several potentially viable options for the disposal of these sediments. Capacity, environmental acceptability and operational viability varied very little. With the exception of the ODMDS, these alternatives beneficially use the dredged material by keeping it in the "system". The determining trade-offs were beneficial use and costs. In attempting to balance ebb tide delta placement with beach placement, the options selected were those that were the most operationally viable and provided the greatest benefit to the littoral system. Measures that are recommended in the base plan are use of a hopper or 30-inch pipeline dredge with placement in the Nearshore West, the Nearshore East or on the beaches of Fort Macon State Park and Atlantic Beach, or Shackleford Banks (currently not an approved placement location as determined by NPS).

Outer Entrance Channel (OEC) - S. Range A from sta. 110+00 - sediments <90% sand									
Measure ID#	Dredging Method	Disposal/Placement Area	Disposal or Placement Capacity (1-5)	Environmental Acceptability (1-5)	Operational Viability (1-5)	Beneficial Use (1-5)	Cost (1-5)	Excluded	Total Score
OEC-1	18 or 30-inch pipeline	Brandt Island	2	5	1	1		X	
OEC-2	Bucket & Barge	ODMDS	5	5	1	1	4*	X	12
OEC-3	hopper	ODMDS	5	5	5	1	5	5	26
OEC-4	Bucket & Barge	Nearshore West	4	1	1	4		X	
OEC-5	Hopper	Nearshore West	4	1	2	4		X	
OEC-6	Bucket & Barge	Nearshore East	4	1	1	5		X	
OEC-7	Hopper	Nearshore East	4	1	2	5		X	
OEC-8	18-inch Pipeline	Fort Macon & Atlantic Beach	5	1	4	1		X	
OEC-9	30-inch Pipeline	Fort Macon & Atlantic Beach	5	1	4	1		X	
OEC-10	18-inch Pipeline	Shackleford Banks Beach	5	1	4	1		X	
OEC-11	30-inch Pipeline	Shackleford Banks Beach	5	1	4	1		X	
OEC-A	Bucket & Barge	Brandt Island	1	5	1	1		X	
OEC-B	30-inch pipeline	Nearshore West or East	4	1	3	5		X	
OEC-C	hopper	Bogue Banks or Shackleford Banks	5	1	4	1		X	
OEC-D	hopper	Marsh Island or Radio Island	1	5	2	1		X	
OEC-E	hopper	Modify Environmental Windows	NA	3	5	NA			8
OEC-F	varies	Construct Waterbird Islands	2	2	1	3	3		11
OEC-G	30-inch pipeline	Create Wetlands	1	3	3	4		X	
OEC-H	varies	Construct New Upland Disposal Site	1	4	4	1		X	
OEC-I	varies	Brandt Island Shoreline Stabilization	NA	3	NA	2		X	
OEC-J	varies	Reduce Channel Dimensions	NA	5	1	NA		X	
* Cost computed for comparison purposes only									

Measure	Reason(s) Measure Eliminated
OEC-1, OEC-A	Not cost effective, long pumping distance
OEC-2 , OEC-4, OEC-6	Operationally not viable (mechanical dredge with scow in open ocean)
OEC-4 thru OEC-11, OEC-B, OEC-C	Sediments not suitable for nearshore or beach placement
OEC-A	Does not provide enough capacity for a single dredging event
OEC-D and OEC-G	Does not provide enough capacity for a single dredging event
OEC-F	- Fine-grained material not suitable habitat for waterbird nesting - Constructing an island with fine-grained material is not operationally viable
OEC-H	No undeveloped uplands exist in the project vicinity
OEC-I	An analysis was performed to determine if stabilizing the north shoreline of Brandt Island would decrease shoaling within the Harbor. Due to the limited change observed during this analysis, a shoreline stabilization measure was not evaluated further.
OEC-J	Current commercial navigation traffic requires the full channel dimensions

Table 3-26. Screening of Measures for Maintenance of South Range A from Station 110+00 out

As shown in Table 3-26, viable options are very limited for the disposal of fine-grained material from the Outer Entrance Channel (South Range A from Station 110+00 out). The only measure that satisfactorily meets all screening criteria is the use of a hopper dredge with disposal in the ODMDS (OEC-3). Therefore, OEC-3 is the recommended measure for the Outer Entrance Channel (blue highlight).

3.4.2 Summary of Recommended Base Plan (DMMP)

Pursuant to ER 1105-2-100, it is the USACE policy to accomplish the disposal of dredged material associated with the construction or maintenance dredging of navigation projects in the least costly manner, consistent with sound engineering practice and in accordance with all federal environmental standards, including the environmental standards established by Section 404 of the Clean Water Act of 1972 or Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (MPRSA), as amended. This constitutes the base plan for the navigation purpose.

As shown in the trade-off analysis, numerous measures were considered and many subsequently eliminated in formulating the base plan for the DMMP. Table 3-27, below, summarizes the status of the disposal measures analyzed and identifies the beneficial use options that were considered. The measures not eliminated from further study make up the base plan, which is described in the following sections.

	Morehead City Harbor DMMP Alternatives & Measures		
#	**Description**	**Beneficial Use**	**Status**
1	**No Action (No DMMP)**	NA	eliminated
2	**Proposed DMMP (Measures Considered)**		
a	Brandt Island upland disposal site	No	in use
b	Place coarse-grained material (≥90% sand) on Bogue Banks	Yes	in use
c	Morehead City Ocean Dredged Material Disposal Site (ODMDS)	No	in use
d	Expand nearshore (ebb tide delta) placement area west of Beaufort Inlet	Yes	proposed
e	Create nearshore (ebb tide delta) placement area east of Beaufort Inlet	Yes	proposed
f	Place Inner Harbor material ≥80% sand in nearshore placement areas	Yes	eliminated
g	Expand and raise Brandt Island dike	No	possible future option
h	Raise existing Brandt Island dike (no expansion)	No	eliminated
i	Transfer Brandt Island material to ODMDS to regain capacity	No	eliminated
j	Recycle Material in Brandt Island through Hydrocyclone Density Separation	Yes	eliminated
k	Place coarse-grained material (≥90% sand) on Shackleford Banks	Yes	Recommended but not implementable
l	Continue to use existing nearshore placement area (no expansion)	Yes	eliminated
m	Modify environmental windows	No	proposed
n	Construct colonial waterbird islands	Yes	eliminated
o	Dispose of dredged material on Radio Island	No	eliminated
p	Dispose of dredged material on Marsh Island	No	eliminated
q	Use dredged material to create wetlands	Yes	eliminated
r	Construct new upland disposal site	No	eliminated
s	Brandt Island shoreline stabilization	Yes	eliminated
t	Construct jetties at Beaufort Inlet	No	eliminated
u	Modify existing groin on west side of Beaufort Inlet	No	eliminated
v	Realign channels to improve navigation and reduce dredging	No	eliminated

Table 3-27. Status of Morehead City Harbor DMMP Measures

Maintenance dredging of authorized Morehead City Harbor Navigation project will continue as described in Section 2.5 (Future Without Project Condition), including adherence to these environmental windows, which include:

- Hopper dredging: No window is required; however, the Wilmington District will consider scheduling hopper dredge activities from January 1 to March 31 to minimize dredging impacts on sea turtles.
- Bucket and barge dredging: No window is required except in the Inner Harbor (Northwest, West and East Legs), which has a window of August 1 to March 31.
- Pipeline dredging: No window is required.
- Disposal: November 16 to April 30 for beach placement on Bogue Banks (Endangered Species Act); September 1 to March 31 for disposal on Brandt Island, if nesting birds; if birds are not nesting, there is no window.
- No window for placement of material in the Nearshore West or Nearshore East is proposed.

The USACE does not propose any seasonal restrictions on placement of material in the Nearshore West or Nearshore East, or on non-hopper dredging of the project (with disposal in Brandt Island, the ODMDS, or the nearshore placement areas, as appropriate). The USACE continues to observe seasonal dredging and placement restrictions as listed above, for the benefit of sea turtles, migratory birds, and a variety of other potentially affected species. These restrictions include the short wintertime hopper dredging window and beach disposal windows that continue to avoid beach disposal during sea turtle nesting season. For other dredging activities and placement in nearshore and ODMDS locations, the marginal benefits associated with seasonal restrictions are not meaningful enough to justify the adverse effects of those restrictions on navigation safety, or to justify the additional costs associated with wintertime dredging.

Management of the dredged material removed during each maintenance cycle will vary; specifically, changes to current maintenance practices include the expansion of the Nearshore West Placement Area and the addition of a new nearshore placement area east of Beaufort Inlet (Nearshore East). A summary of the base plan (DMMP) as compared to the No Action plan is shown below in Table 3-28 and the cycle of dredging and disposal proposed for the 20-year plan is shown in Table 3-29. Table 3-30 shows the proposed DMMP cycle, sediment quality, sediment volumes and disposal/placement locations for each year of the 20-year plan.

The recommended base plan is shown graphically on Figures 3-41 thru 3-43, below. Figure 3-43 shows Inner Harbor material going to Brandt Island every 3 years, however, after year 2028, when Brandt Island reaches capacity, this material likely will be disposed of in the ODMDS. Figure 3-44 shows all dredging and disposal areas addressed in this DMMP.

Plan	Navigation Section	Range	Dredging Freq. (year)	Brandt Island	Fort Macon/Atlantic Beach	Nearshore West	Nearshore East	ODMDS
Proposed DMMP	Inner Harbor	Northwest Leg/West Leg 1/East Leg (<80% sand)	3	362,000	none	none	none	none
		West Leg 2 /North Range C (≥80% sand)	3	152,000	none	*	*	none
	Outer Harbor	S. Range C-N. Range B (≥90% sand)	3	none	none	270,000	76,000	**
		S. Range B, Cutoff, N. Range A (≥90% sand)***	1	none	1,200,000	1,139,000	321,000	**
	Outer Entrance Channel	S. Range A, Sta.110 out (<80% sand)	3	none	none	none	none	344,000
No Action	Inner Harbor	Northwest & West Leg	3	362,000	none	none	NA	
		East Leg-N. Range C	3	152,000	none	none	NA	none
	Outer Harbor	S. Range C-N. Range B	3	none	none	346,000	NA	~40% of total
		S. Range B, Cutoff, N. Range A	1	none	1,200,000	1,500,000	NA	~40% of total
	Outer Entrance Channel	S. Range A, Sta.110 out	3	none	none	none	NA	344,000

* This material may go in the nearshore if costs are feasible, i. e. combined with an AIWW contract

** Contracts may limit disposal in the ODMDS during adverse weather to approx. 20% of total

*** For this Range, Year 1 of the 3-yr. dredging cycle to be done by 30" pipeline;2nd & 3rd years to be done by hopper

Table 3-28. Comparison of Proposed DMMP (base plan) with the No Action Plan. Dredging Quantities Rounded.

DMMP Cycle	Harbor Section	Navigation Range Dredged	Dredge Plant	Proposed Disposal/Placement Location	Quantity Likely to be Dredged (cy)	Estimated Cost (per dredging event)*
Years 1,4,7,10…	Outer	South Range B Cutoff North Range A to Station 110+00	30-inch** pipeline	Fort Macon State Park & Atlantic Beach***	1,200,000	~$18,839,800
Years 2,5,8,11…	Outer	South Range C to North Range B	Hopper or pipeline	Nearshore West &/or East	346,000	~$7,571,000
	Outer	South Range B Cutoff North Range A to Station 110+00	Hopper or pipeline	Nearshore West &/or East	650,000	
Years 3,6,9,12…	Inner	Northwest Leg West Legs 1 & 2 East Leg & North Range C	18-inch pipeline	Brandt Island or ODMDS	514,000	~$12,219,900****
	Outer	South Range B Cutoff North Range A to Sta. 110+00	Hopper or pipeline	Nearshore West &/or East	810,000	
	Outer Entrance	South Range A from Station 110+00 out	hopper	ODMDS	344,000	

* Costs include monitoring, mobilization/demobilization, planning, engineering and design, supervisory and administrative costs and 27% contingency
** Costs estimates are based on the specific pipeline sizes this table; however comparable sized pipeline dredges could be used
***Non-federal entities may contribute funds through an Additional Work Memorandum of Agreement (MOA) for dredging with placement of beach quality material on Bogue Banks beaches. Refer to section 6.2 of this Plan for details.
**** When Inner Harbor material is disposed of in the Ocean Dredged Material Disposal Site (ODMDS) (once Brandt Island reaches capacity), costs increase to $14,101,200 per dredging event.

Table 3-29. Proposed DMMP Cycle of Dredging and Disposal (numbers rounded)

				Estimated Dredged Material Quantity (cu. yds.)			
DMMP Year	**Fiscal Year**	**Harbor Section**	**Sediment Quality**	**Nearshore**	**Beach**	**Brandt Island**	**ODMDS**
1	2017*	Outer	coarse-grained**		1,200,000		
2	2018	Outer	coarse-grained	996,000			
3	2019	Inner	fine-grained***			514,000	
		Outer	coarse-grained	810,000			
		Outer Entrance Channel	fine-grained				344,000
4	2020	Outer	coarse-grained		1,200,000		
5	2021	Outer	coarse-grained	996,000			
6	2022	Inner	fine-grained			514,000	
		Outer	coarse-grained	810,000			
		Outer Entrance Channel	fine-grained				344,000
7	2023	Outer	coarse-grained		1,200,000		
8	2024	Outer	coarse-grained	996,000			
9	2025	Inner	fine-grained			514,000	
		Outer	coarse-grained	810,000			
		Outer Entrance Channel	fine-grained				344,000
10	2026	Outer	coarse-grained		1,200,000		
11	2027	Outer	coarse-grained	996,000			
12	2028	Inner	fine-grained			514,000	
		Outer	coarse-grained	810,000			
		Outer Entrance Channel	fine-grained				344,000
13	2029	Outer	coarse-grained		1,200,000		
14	2030	Outer	coarse-grained	996,000			
15	2031	Inner	fine-grained			514,000	
		Outer	coarse-grained	810,000			
		Outer Entrance Channel	fine-grained				344,000
16	2032	Outer	coarse-grained		1,200,000		
17	2033	Outer	coarse-grained	996,000			
18	2034	Inner	fine-grained			514,000	
		Outer	coarse-grained	810,000			
		Outer Entrance Channel	fine-grained				344,000
19	2035	Outer	coarse-grained		1,200,000		
20	2036	Outer	coarse-grained	996,000			
		Inner	fine-grained			514,000	
		Outer Entrance Channel	fine-grained				344,000
			TOTALS	**11,832,000**	**8,400,000**	**3,598,000**	**2,408,000**
* The DMMP will be completed in October 2016 (Fiscal Year 2017)							
**coarse-grained = dredged material ≥90% sand				***fine-grained = dredged material <90% sand			

Table 3-30. Proposed DMMP Cycle - Sediment Quality & Disposal/Placement Locations

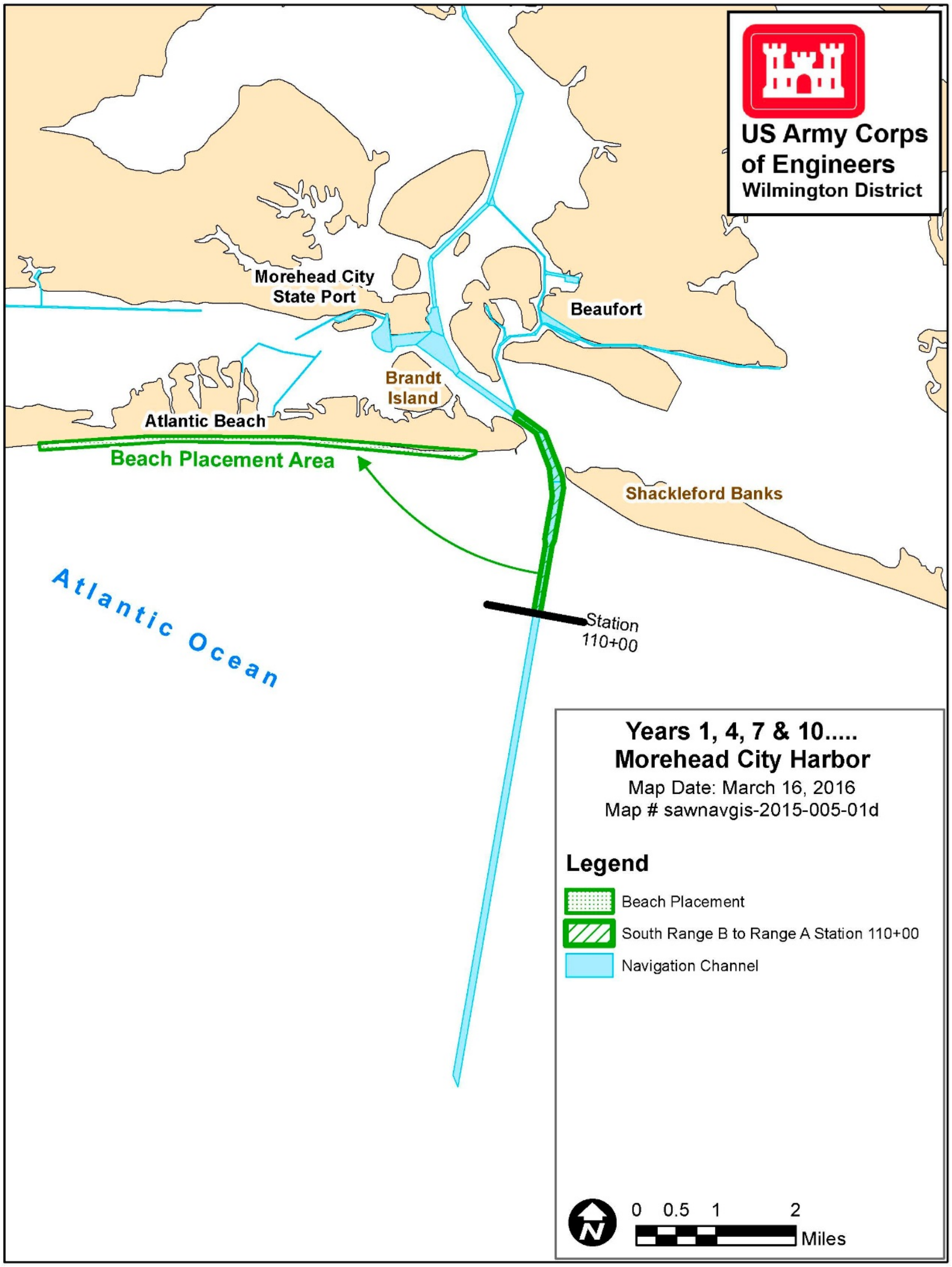


Figure 3-41. Proposed Base Plan – Years 1,4,7,10…….

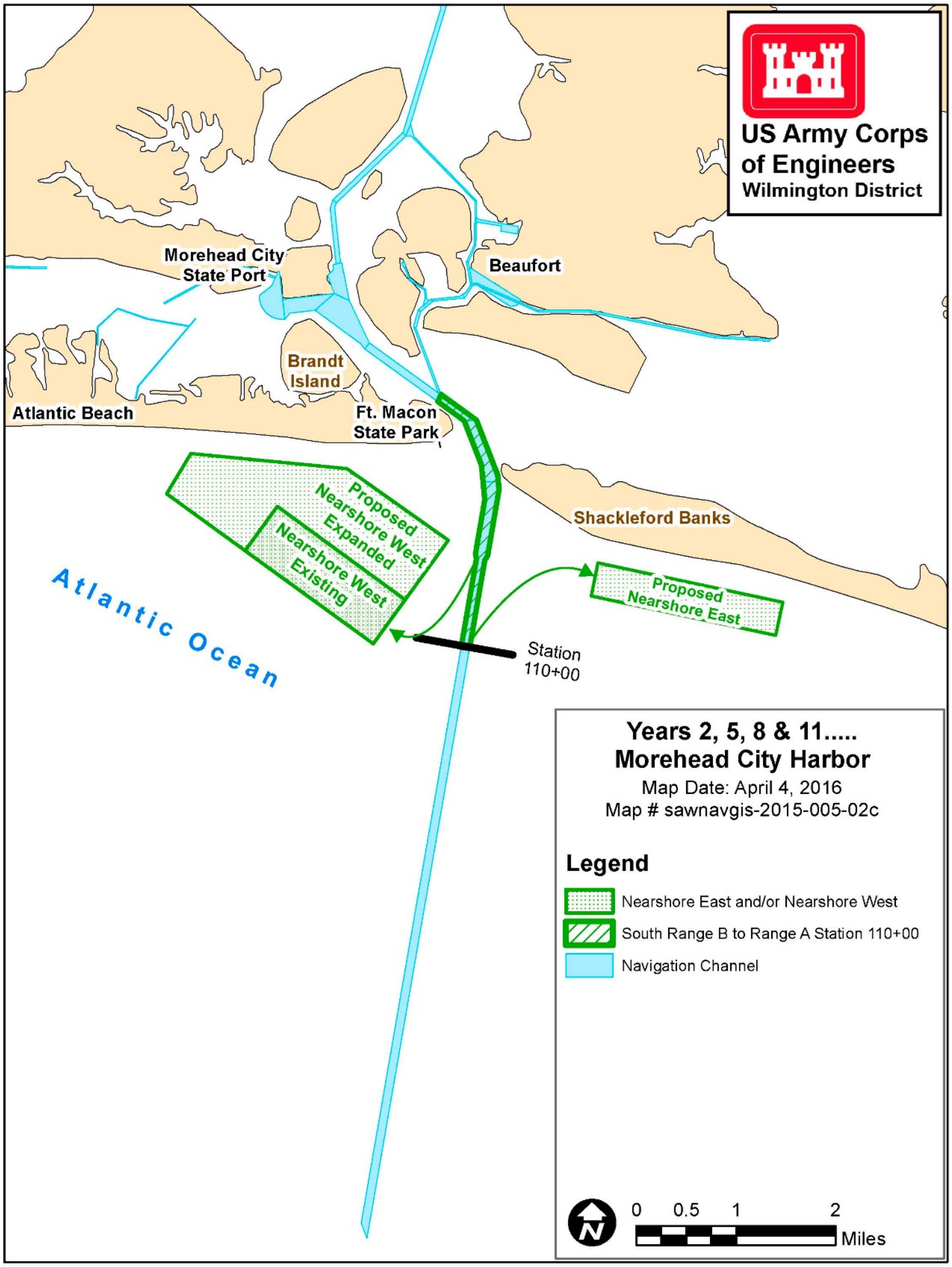


Figure 3-42. Proposed Base Plan – Years 2, 5, 8,11…..

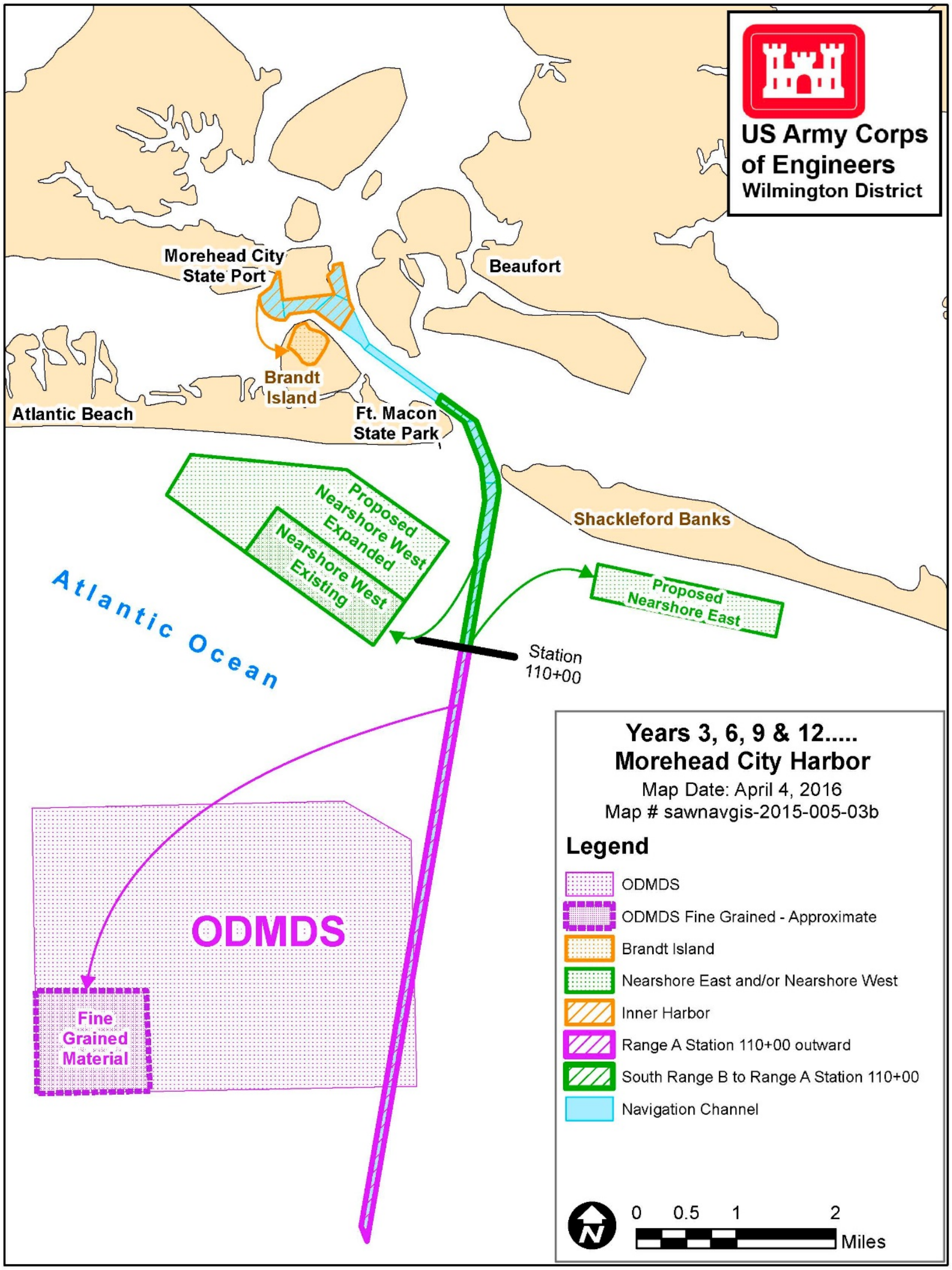


Figure 3-43. Proposed Base Plan – Years 3,6,9,12………

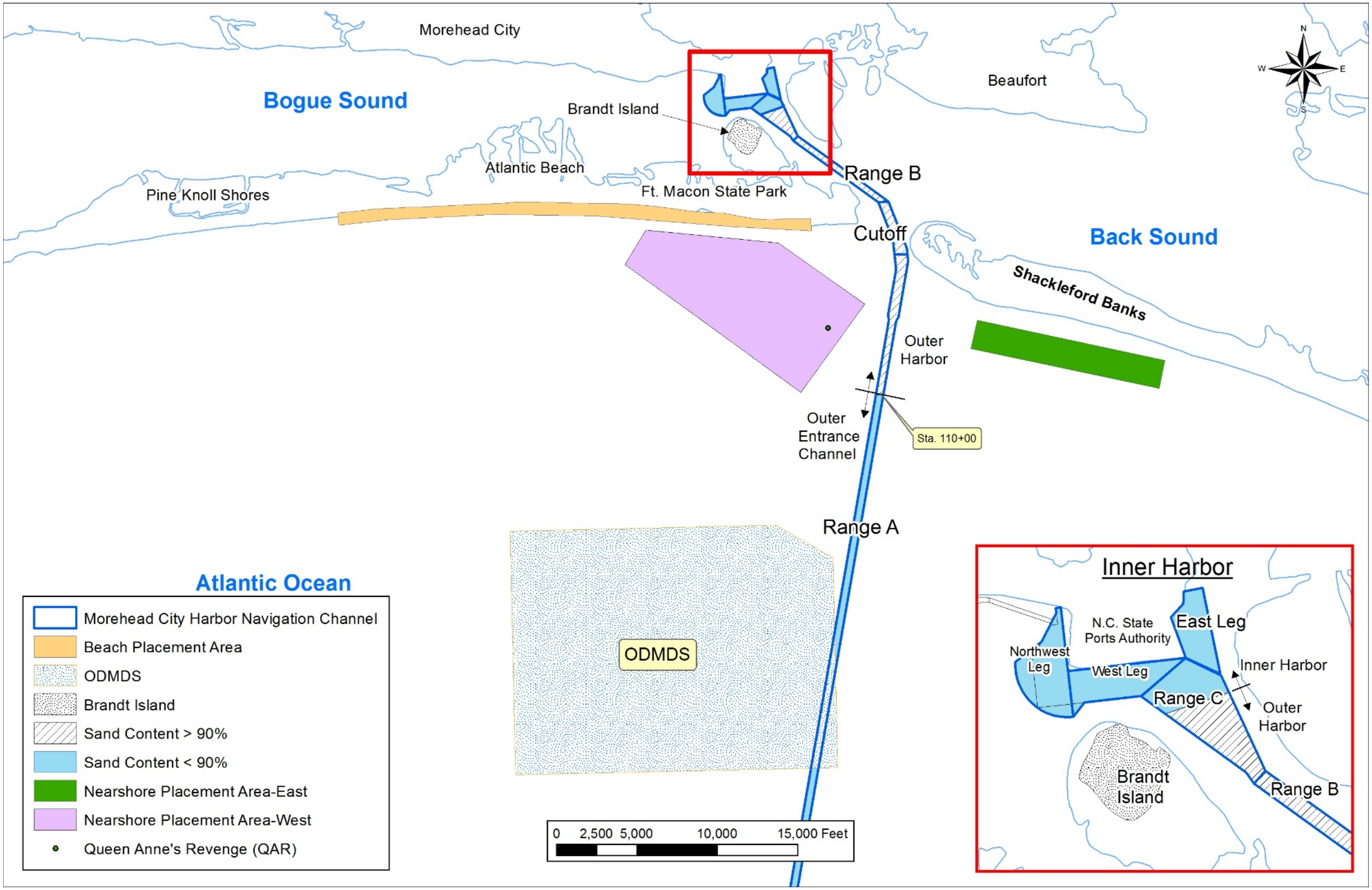


Figure 3-44. Summary of all Dredging and Disposal Locations

As shown in the tables and figures above, the proposed base plan is based on a 3-year maintenance cycle, which is the most efficient way to maintain the Harbor. Specifically, and as further described below, the 3-year plan balances the following important elements of long-term project maintenance:

1) Staggered needs for channel maintenance. Due to differences in shoaling rates, different reaches of the channel require maintenance at different intervals. Some must be maintained annually and some can be effectively maintained on a less frequent basis. Specifically, most of the Inner Harbor reaches can be maintained approximately once every 2 or 3 years and still support traffic. The Outer Entrance Channel can also be maintained roughly once every 2 to 3 years. The Cutoff area and some portion of Range A requires annual maintenance dredging.

2) Optimum dredge plant for channel maintenance. Different types of dredge plant are most effective for dredging different areas of the channel. The Outer Entrance Channel can only be effectively maintained by a hopper dredge, as it is 47 feet deep, experiences string-bean shoaling, is far from shore, and close to the ODMDS disposal area. The rest of Range A can be effectively maintained by either a hopper or a large cutterhead pipeline dredge, and flexibility is required; depths are still 47 feet, open ocean conditions exist, and string bean shoals do occur, but if bank height from encroaching shoals is high enough, a pipeline may be the best tool. The Cutoff needs a large cutterhead pipeline (at least 24", preferably 30") to meet the full channel prism, as the encroaching tip of Shackleford Island creates large, steep shoals. A hopper dredge can effectively maintain the central channel of the Cutoff in subsequent years, but if a pipeline dredge is not mobilized at least once every three years, the slopes become too steep for a hopper dredge to effectively operate. Range A and the Cutoff can also be maintained by a bucket and barge. Ranges B and C can be maintained effectively by any type of dredge, allowing them to be added to any contract as needed; disposal locations, more than dredging conditions, dictate dredge plant requirements. The Inner Harbor reaches are tight quarters that cannot be effectively navigated by hopper dredges; overflow restrictions also limit hopper effectiveness (and reduce mechanical dredge efficiency as well). A small (18") pipeline dredge is usually the best tool in these areas, but occasionally a mechanical dredge may be best.

3) Environmental considerations. Important environmental considerations include water quality, endangered and threatened species, essential fish habitat, and benthic organisms. Other considerations include the need to not place material on the same stretch of beach in subsequent years to allow for benthic species recovery, and the need to provide some regular inputs of sand to both sides of the ebb tide delta and both adjacent shorelines (although NPS has requested that no material be placed on the Shackleford Banks beach).

4) Cost. In order to maintain all areas of the project in a way that allows for the Port to operate effectively and allow USACE the ability to use its funds efficiently, some form of dredging contract will be required at Morehead City Harbor annually, incorporating different areas of the project in a manner that best utilizes the dredge plant necessary to

do the work. Shoaling always makes some amount of maintenance necessary, and the District strives each year to incorporate into its contract the most pressing navigation needs. Therefore adequate contract planning is critical to successfully meet the project's anticipated shoaling for each year. Beach placement is very expensive, and cannot likely be afforded more than once every three years at best; however, the Cutoff can only be properly maintained with periodic use of a cutterhead pipeline dredge, so the plan must account for that type of contract often enough to keep the channel open. It is the need for a cutterhead pipeline dredge which drives the 3-year cycle of this plan -- if a cutterhead pipeline dredge is mobilized less than once every three years, the slopes of the cutoff channel steepen and the channel closes in to a degree that it cannot be effectively maintained by a hopper in the off-years. Additionally, the potential of project-induced erosion increases, particularly at the ends of the flanking barrier islands. If a pipeline dredge is mobilized more often than once every three years, costs become too great, the effects on beach organisms increase, and less material is provided to the ebb tide delta.

In summary, Wilmington District USACE recommends a 3-year cycle that most effectively matches anticipated dredge plant with the areas that need to be maintained. This plan is the best balance of dredging needs, available dredge plant, environmental concerns, and costs.

The USACE continues to recommend placement of sand on Shackleford Banks; however, since the NPS requested that this disposal option be dismissed as part of this DMMP, placement of sand on Shackleford Banks is not implementable.   As shown in Table 3–27, the proposed base plan provides more than one potential disposal option for most of the ranges of the Morehead City Harbor navigation channels, depending on the type of dredge equipment mobilized. Although dredged material from most of the Morehead City Harbor ranges may be disposed of in more than one location, Table 3–27 displays the plan that best meets the Federal standard of least cost, engineeringly sound and environmentally acceptable disposal. The 3-year cycle is graphically depicted in Figures 3-41 through 3-43. Quantities shown in the tables above are based on adjusted shoaling rates (Section 2.4) and represent the material likely to be dredged in order to maintain the channel to authorized dimensions. However, due to funding limitations and navigation priorities, actual dredging quantities from the Morehead City Harbor channels will vary and are expected to be less than the quantities shown above.

As shown in Table 3-29, plans are to dredge the Outer Harbor reaches annually. During the first year, the Outer Harbor ranges (from South Range C out to Station 110+00 of Range A) would be dredged by a 30-inch pipeline to the fully authorized project depth of 45’+ 2 feet of allowable overdepth (or 47’+2, as appropriate) with placement on the beaches of Fort Macon State Park and Atlantic Beach. Comparison of the volumetric losses calculated earlier in this section shows that the recent loss trends for both islands are relatively similar. The recommended plan was for the coarse-grained (≥90% sand) dredged material to be returned to the beaches in ratios comparable to calculated sediment losses, resulting in a 57/43 split of material placed on Bogue Banks and Shackleford Banks, respectively. Following the initial placement, these ratios were to be reevaluated based on the performance of the material placed, and beach placement limits would have been adjusted to maximize the benefits while minimizing costs and environmental impacts. The National Park Service had the option to decline the placement of dredged material on Shackleford Banks during any maintenance dredging event. However, since the NPS has requested that no sand be placed on Shackleford Banks, all beach placement for the next 20 years is likely to be on the beaches of Fort Macon and Atlantic Beach (or Pine Knoll Shores, if non-federal interests pay the additional costs). Under the base plan, quantities expected to be placed on the beaches are greater than quantities placed on the beach in the past from the Brandt Island pumpout.

During the second and third years of the 3-year maintenance cycle, a hopper dredge (or pipeline dredge with dump scows or approved direct pipeline method) would be mobilized to dredge the Outer Harbor ranges out to Station 110+00 to authorized project depth with placement of material in the nearshore placement areas. Dredged material quantities to be placed in the Nearshore Areas would be roughly based on the ratio of the historic losses for the two lobes (west and east) of the ebb tide delta. As discussed in Section 3.2.4 Ebb Tide Delta, 78% of sediment losses occurred on the west ebb tide delta and 22% of losses occurred on the east ebb tide delta. Therefore, material placed within the ebb tide delta will be split between the western and eastern lobes based on this 78/22 ratio, respectively, if operationally feasible. Over the life of this DMMP, it is the USACE's intent to meet this 78/22 ratio, although individual dredging jobs will likely use a single nearshore placement area. Quantities of material dredged in non-beach placement years (years two and three of the 3-year cycle) that exceed the annual losses to the ebb tide delta may be available for beach placement by a local entity. Any requests by local entities to place this excess dredged material on adjacent beaches would be evaluated on a case-by-case basis and would be funded by the requesting entity.

On infrequent occasions, small quantities of dredged material (typically less than 100,000 cubic yards) that contain at least 90% sand may be disposed of in Brandt Island. This situation is likely to be confined to situations where a small pipeline dredge is maintaining the Inner Harbor, and needs to dredge some quantity of Range B or Range C material that may contain higher sand percentages.

The disposal of all Outer Harbor material will be based on data provided by the Morehead City Harbor Monitoring Plan (Appendix F) and beach placement limits may be modified to best address any shoreline conditions. Additionally, quantities placed will always be subject to navigation priorities and the availability of dredging funds which may not be sufficient to place quantities equivalent to the historic loss rates.

Sediments in the Outer Entrance Channel (Range A from Station 110+00 seaward) are predominantly fine-grained and cannot be placed on the beaches or in the nearshore placement areas. The least cost, engineeringly sound, environmentally acceptable alternative for the Outer Entrance Channel sediments is disposal in the ODMDS. The

DMMP proposes to dredge this portion of the Harbor to a depth of 47'+2 by hopper dredge in year three of the three-year cycle.

3.4.3 Real Estate

The DMMP addresses dredging needs, disposal capabilities, and capacities of disposal areas with the purpose of ensuring sufficient disposal capacity for at least the next 20 years, beginning in 2016 and extending through 2035. The Proposed Base Plan to accomplish the disposal of dredged material associated with the maintenance dredging of Morehead City Harbor is discussed at Section 3.4 (Proposed Base Plan (DMMP)). Maintenance dredging is proposed for three areas, the Inner Harbor, Outer Harbor and Outer Entrance Channel. Areas considered for disposal of dredged material are:

- Brandt Island
- Beaches at Fort Macon State Park, Atlantic Beach
- Nearshore West
- Nearshore East
- Ocean Dredged Material Disposal Site (ODMDS)

<u>Brandt Island.</u> A large portion of the Island (Figure 1-4) is owned by the State of North Carolina and since the 1950's has been dedicated for use as a disposal area. It is proposed that dredged material from the Inner Harbor be disposed of in Brandt Island. For past disposal events the State of North Carolina has either granted a temporary disposal easement or given a letter permit for use of the Brandt Island site. The same would be required for any subsequent use of the site.

<u>Beaches at Fort Macon State Park.</u> Dredged materials from the Outer Harbor will likely be placed on the beach of Fort Macon State Park (Figure 1-4), which is owned by the State of North Carolina. No formal agreement exists between the USACE and the State pertaining to placement of material at Fort Macon. However, prior to each placement event, the USACE coordinates closely with the State Park regarding the details of the placement activity and obtains approval for placement of dredged material on the Fort Macon shoreline. Either an easement or a letter permit from the State will be required to make Fort Macon State Park available for project purposes.

<u>Beaches of Atlantic Beach</u>. Dredged materials from the Outer Harbor will also be placed on Atlantic Beach (Figure 1-4), which is privately owned landward of mean high water (mhw). In 2005, sand was pumped from Brandt Island onto the beaches of Fort Macon and Atlantic Beach to create more disposal capacity within the Brandt Island site. At that time, 209 parcels on Atlantic Beach were impacted by the placement of fill. There were 150 perpetual easements in place and 59 temporary easements were acquired, which have since expired. The easement language used in the acquired easements was very similar to the standard “Perpetual Beach Storm Damage Reduction Easement” shown below.

An assumption is that the last sand disposal created new lands which vested in State ownership. The expectation with future disposal events is that fill will be placed on or below the land created at the last fill and that no further real estate interests will be required; however, this will be confirmed when surveys are completed prior to each beach placement event. Should there be areas where erosion has occurred landward of the old mean high water line, easements will be required from impacted landowners. It is suggested that the standard Perpetual Beach Storm Damage Reduction Easement be used if additional easements are required.

PERPETUAL BEACH STORM DAMAGE REDUCTION EASEMENT

> A perpetual and assignable easement and right-of-way in, on, over and across (the land described in Schedule A) (Tract No. __) for use by the (Project Sponsor), its representatives, agents, contractors, and assigns, to construct; preserve; patrol; operate; maintain; repair; rehabilitate; and replace; a public beach [a dune system] and other erosion control and storm damage reduction measures together with appurtenances thereto, including the right to deposit sand; to accomplish any alterations of contours on said land; to construct berms [and dunes]; to nourish and renourish periodically; to move, store and remove equipment and supplies; to erect and remove temporary structures; and to perform any other work necessary and incident to the construction, periodic renourishment and maintenance of the (Project Name), together with the right of public use and access; [to plant vegetation on said dunes and berms; to erect, maintain and remove silt screens and sand fences; to facilitate preservation of dunes and vegetation through the limitation of access to dune areas;] to trim, cut, fell, and remove from said land all trees, underbrush, debris, obstructions, and any other vegetation, structures and obstacles within the limits of the easement (except___*__); [reserving, however, to the grantor(s), (his) (her) (its) (their) (heirs), successors and assigns, the right to construct dune overwalk structures in accordance with any applicable Federal, State or local laws or regulations, provided that such structures shall not violate the integrity of the dune in shape, dimension or function, and that prior approval of the plans and specifications for such structures is obtained from the (designated representative of the Project Sponsor) and provided further that such structures are subordinate to the construction, operation, maintenance, repair, rehabilitation and replacement of the project; and further] reserving to the grantor(s), (his) (her) (its) (their) (heirs), successors and assigns all such rights and privileges as may be used and enjoyed without interfering with or abridging the rights and easements hereby acquired; subject however to existing easements for public roads and highways, public utilities, railroads and pipelines.

The worst case scenario under the recommended base plan is acquisition of 59 easements. Real Estate cost would include the review and certification of Real Estate prior to advertisement for construction. The estimated cost is $6,500 (Appendix N). Should future beach placement occur on Bogue Banks west of the area included in the base plan, additional easements would be required, incurring additional real estate costs that cannot be accurately estimated at this time. Placement of sand along the shoreline is considered beneficial use of dredged material and is not considered a nourishment project. The non-federal sponsor will not receive credit for cost incurred in the acquisition of easements.

Nearshore West. The Nearshore West Placement Area (Figure 3-25) is within State waters and is located off Bogue Banks. Dredged material from the Outer Harbor will be disposed of in the Nearshore West site. The existing site is 559 acres but the recommended base plan proposes to expand the existing site by an additional 1,209 acres. This is discussed in further detail in Sections 4 and 5 of this report. The proposed expansion is being coordinated with all appropriate resource agencies and approval from the State will be obtained prior to use of the expanded area.

Nearshore East. The Nearshore East Placement Area (Figure 3-26) is a newly proposed site that will consist of approximately 1,094 acres and will be located within State waters off Shackleford Banks. Dredged material from the Inner Harbor will be placed in the Nearshore East. This is discussed in further detail in Sections 4 and 5 of this report. The proposed Nearshore East is being coordinated with all appropriate resource agencies and approval from the State will be obtained prior to use of the expanded area.

ODMDS. The ODMDS (Figure 3-43) is an 8 square nautical mile area located on the Outer Continental Shelf (OCS). The site was designated by USEPA as an ocean dredged material disposal site. The transportation and disposal of dredged material in ocean waters, including the territorial sea, is regulated under the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA) (Public Law 92-532, 86 Stat. 1052, 33 U.S.C. §§1041 et seq.) as amended by Title V of the Water Resources Development Act of 1992 (WRDA 92; Public Law 102-580). Section 102(a) of MPRSA authorizes the USEPA to establish and apply regulations and criteria for ocean dumping activities. Consequently, the USEPA issued in October, 1973, and revised in January, 1977, Ocean Dumping Regulations and Criteria (40 CFR 220-238). These regulations establish control of ocean dredged material disposal primarily by two activities, designation of sites for ocean dumping and the issuance of permits for dumping.

The transportation of dredged material for the purpose of disposal into ocean waters (i.e. the actual use of the designated site) is permitted by USACE (or authorized in the case of federal projects) under MPRSA Section 103(e) applying environmental criteria established in USEPA's Ocean Dumping Regulations and Criteria. The MPRSA Section 104(a)(3) provides that ocean disposal of dredged material can occur only at a designated site and Section 103(b) requires the USACE to utilize dredged material disposal sites designated by USEPA to the maximum extent feasible. Prior to issuing a dredged material permit or authorizing a federal project involving the ocean disposal of dredged material, the USACE must notify USEPA, who may disapprove the proposed disposal. Dredged material from the Inner Harbor, Outer Harbor and Outer Entrance Channel may be disposed of in the ODMDS.

No staging areas have been identified at the time of this report. When specific requirements are determined, the sponsor will be responsible for providing staging areas for the project prior to advertisement for construction. However, should a contractor determine that another site may be more convenient or suitable, it will have the option to obtain an alternate site for staging.

4 AFFECTED ENVIRONMENT

Background. Section 3.4.2 describes the Proposed Base Plan and Figures 3-41 through 3-43 graphically show the proposed base plan. The project area is located in the lower Atlantic Coastal Plain Physiographic Province, along the central coast of North Carolina. More specifically, the Morehead City Harbor channel passes through Beaufort Inlet between the barrier islands of Shackleford Banks and Bogue Banks and continues inland to the mainland at Morehead City and Beaufort, North Carolina. The channel is flanked by shoals of the ebb-tidal delta seaward of the inlet and by those of the flood-tidal delta landward along Back Sound on the east. Farther inland, the channel is flanked by Bogue Sound on the west. The Newport River empties into Morehead City Harbor at the head of the channel, i.e., the northernmost end of the Harbor. The DMMP study area encompasses depositional environments that include nearshore littoral settings, an active coastal inlet, barrier islands, and a shallow, back barrier lagoon complex of sounds and channels.

Bogue Banks is the longest island south of Cape Lookout. It is a 25-mile barrier island, stretching from Bogue Inlet to Beaufort Inlet in Carteret County. The barrier island, separated from the mainland by Bogue Sound, runs east to west, with the ocean beaches facing due south. Bogue Banks is developed and can be accessed by one of two bridges across Bogue Sound, either from Morehead City to Atlantic Beach, which is the more heavily traveled bridge, or from Cape Carteret to Emerald Isle. The State Park and communities of Bogue Banks are (from east to west) Fort Macon State Park, Atlantic Beach, Pine Knoll Shores, Salter Path/Indian Beach, and Emerald Isle. Bogue Banks includes some hotels/motels but is dominated by private homes, many of which are rented out during the summer. Bogue Banks also contains areas of maritime forest. Stores and other commercial properties are limited to the five main communities. The proposed dredged material placement area on Bogue Banks is about 10 miles in length and extends from Fort Macon State Park to Pine Knoll Shores.

Shackleford Banks is a barrier island that is part of the National Park Service (NPS), Cape Lookout National Seashore (CALO), which consists mostly of wide bare beaches with dunes covered by scattered grasses, flat grasslands bordered by dense maritime vegetation, and large expanses of salt marsh alongside Back Sound. Congress established Cape Lookout National Seashore (CALO) in 1966 to conserve and preserve for public use and enjoyment the outstanding natural, cultural, and recreational values of a dynamic coastal barrier island environment for future generations. The CALO is located three miles off the mainland coast in the central coastal area of North Carolina and occupies more than 29,000 acres of land and water from Ocracoke Inlet on the northeast to Beaufort Inlet to the southwest. The CALO National Seashore consists of four main barrier islands (North Core Banks, Middle Core Banks, South Core Banks, and Shackleford Banks). There are no road connections to the mainland or between the islands. Shackleford Banks is located adjacent to the existing Cutoff reach of the federal navigation channel. The beachfront area serves as a high-usage recreation beach for visitors transported by private boats or to the existing pier/dock via ferry vessels from Harkers Island, Beaufort, and Morehead City.

4.1 Physical Resources

4.1.1 Sediment Background

The following information (in italics) was taken from Appendix B, Geotechnical Appendix, Feasibility Report and Environmental Assessment, Morehead City Harbor Improvement, Morehead City, North Carolina, dated June 1990 and revised December 1990 (USACE 1990):

The prominent geographical feature of the region is Cape Lookout, which is composed of a lobate sand body ranging up to 90 feet in thickness and covering an area of approximate 100 square miles. The western edge of the Cape Lookout shoal lies immediately east of the entrance channel. Shackleford Banks is a Holocene age barrier island that is underlain by extensive deposits of inlet filled sediments along its entire length. Historically, an inlet or inlets have opened and closed along the full length of the island, while displaying an overall westward lateral movement to the present-day Beaufort Inlet location. Back Sound, landward of Shackleford Banks, is underlain by stacked sequences of flood-tidal delta deposits, which stratigraphically compliment the inlet-fill sequences under the island. Holocene age shoreface deposits underlie Bogue Banks, to the west of the channel. The barrier sands of the island are prograding seaward over these deposits at present. Bogue Sound, landward of this island, is underlain by back-barrier lagoonal sequence of sediments having a greater abundance of clays than Back Sound to the east. The entire sequence of barrier/back-barrier sediments in the area represents several transgressive/regressive ocean events that occurred during Pleistocene and Holocene time.

Sediments within the Morehead City Harbor channels range from Pliocene to Holocene in age. The Pliocene sediments are from the Yorktown formation and are only found in limited areas (i.e., the turning basin and possibly along portions of Ranges B and C). The top of the Yorktown sediments range between –45 and –50 mean sea level (MSL) in the Inner Harbor area and to about –65 feet MSL at Beaufort Inlet. These sediments consist of bluish to greenish-gray, clayey sands and interbedded clay and sandy clay, all of which have abundant fossil debris. Generally the Yorktown is more indurated than the overlying sediments. The Pleistocene sediments are from the Core Creek Sand. Within the inlet, these sediments are at approximately –50 to –54 feet msl. Beneath Bogue Banks and Shackleford Banks, the Pleistocene varies from –45 feet msl to –55 feet msl, respectively. In the landward direction, the top of the Core Creek Sand rises along the dip such that it is only 15 to 20 feet below msl. Pleistocene deposits from

Beaufort sand form a ridge along the mainland at the rear of Back and Bogue Sounds, as part of the Core Creek Plain (Pamlico Plain of Stephenson, 1912). This plain is a shallow, seaward dipping surface, which lies east and south of the Suffolk Scarp. In general, the Pleistocene sediments in the project area are representative of back-barrier and nearshore or shoreface deposits consisting of interbedded clays, silts, and fine sands, and poorly graded fine to medium sands and shelly sands, respectively. Holocene sediments are undifferentiated. They are the uppermost sediments at the site. Within the inner harbor, they consist of some reworked clays and silts but are predominately very fine to fine sands that are derived from Bogue and Back Sounds and the Newport River. Coarser sediments are concentrated in the channels. Holocene deposits are derived from the ongoing reworking of older sediments along the nearshore seabed and the Cape Lookout sand body. Deposits in each of the stratigraphic units are interbedded vertically and interfinger horizontally (facies changes) as the environments of deposition changed across the project area.

4.1.2 Sediment Characteristics

This section describes the sediment analyses that have been completed for the beaches of Shackleford Banks and Bogue Banks as well as the navigation channel sediments. In 2010, the NPS requested that the DMMP include the option of placing sand on Shackleford Banks, so a detailed analysis of the material dredged compared to the native beach on Shackleford Island was performed to confirm that dredged material from the Harbor would be acceptable for placement on Shackleford Banks. Dredged material from the Morehead City Harbor project has been placed on the beaches of Bogue Banks periodically since 1978 and sediment compatibility has not been an issue; therefore the sediment analyses completed for Bogue Banks were not as rigorous as the analyses for Shackleford Banks.

Following public review of the draft DMMP, the NPS requested dismissal of the alternative to place coarse-grained material on Shackleford Banks; therefore no beach placement will occur on Shackleford Banks as part of this DMMP. All beach placement will take place on the beaches of Fort Macon State Park and Atlantic Beach (Bogue Banks). The USACE guideline for beneficial use beach placement is no more than 10% of the material passing the # 200 sieve, i. e., dredged material must be 90% sand (coarse-grained). All dredged material that will be placed on the beaches of Bogue Banks meets the USACE guideline and is dredged from the same channel reaches of the Harbor that have been placed on the Bogue Banks beaches in the past.

Section 4.1.3 describes the sampling efforts and sediments in the nearshore placement areas.

Shackleford Banks. In May 2011, the Wilmington District completed the characterization of the native beach sediment on Shackleford Banks (USACE 2011). About 14 sediment samples were taken along each of 46 transects (from the beach dune to -30 foot elevation) about every 1,000 feet of shoreline on Shackleford Banks from Barden (Transect 00) to Beaufort (Transect 460) Inlets. Figures 4-1 and 4-2 show transect and sample locations along each transect on Shackleford Banks.

In the upland beach area, six surface samples were collected. For each transect, one grab sample was collected from each of the following six locations:

1) dune (DN);
2) seaward toe of the dune, dune base (DB);
3) crest of the berm (BC) approximately elevation +7 NGVD;
4) mean high water (MHW), approximately elevation +2.1 NGVD;
5) mean sea level (MSL) , approximately +0.0 ft NGVD; and
6) mean low water (MLW), approximately elevation –1.9 NGVD.

In the ocean, eight surface samples were collected from each of the transect lines. For each transect, one grab sample was taken at 6-foot increments of elevation beginning at elevation -6 NGVD through elevation –30 NGVD. In addition, a sample was taken at the trough, the bar crest, and -10 MLW. Transects which intersect Barden's Inlet were sampled to the deepest point of the Inlet. Samples were not taken along the transect beyond the deepest part of Barden's Inlet. The samples were collected from the top one to four inches of ground surface.

The grain size distributions of the 647 Shackleford Banks sediment samples were analyzed using the American Society for Testing and Materials (ASTM) test procedure D 422 entitled "Standard Test Method for Particle-Size Analysis of Soils" and D 2487 "Classification of Soils for Engineering Purposes". The following 16 sieve sizes were used: 3/4", 3/8", #4, #7, #10, #14, #18, #25, #35, #45, #60, #80, #120, #170, #200, and #230 for the test procedure D 422. The hydrometer portion for the test procedure D 422 was not required for the material passing the Number 230 sieve. The percent shell content of each sample was determined by estimating visually the amount of shell on each sieve, during the sieve procedure, to determine the overall sample shell content. The color of all sediment samples (dry) was determined using the Munsell Color System.

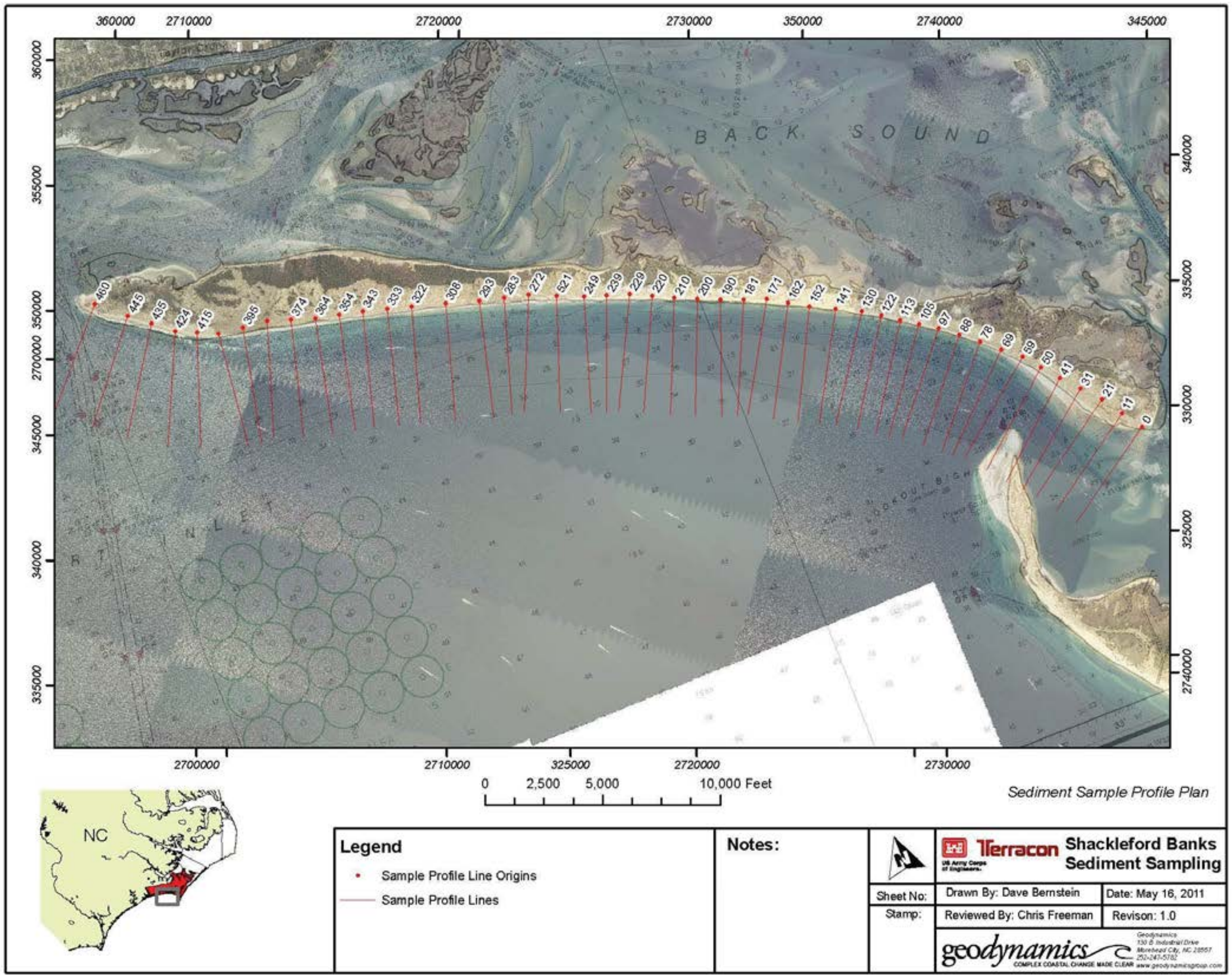


Figure 4-1. Shackleford Banks Sediment Sampling Transects.

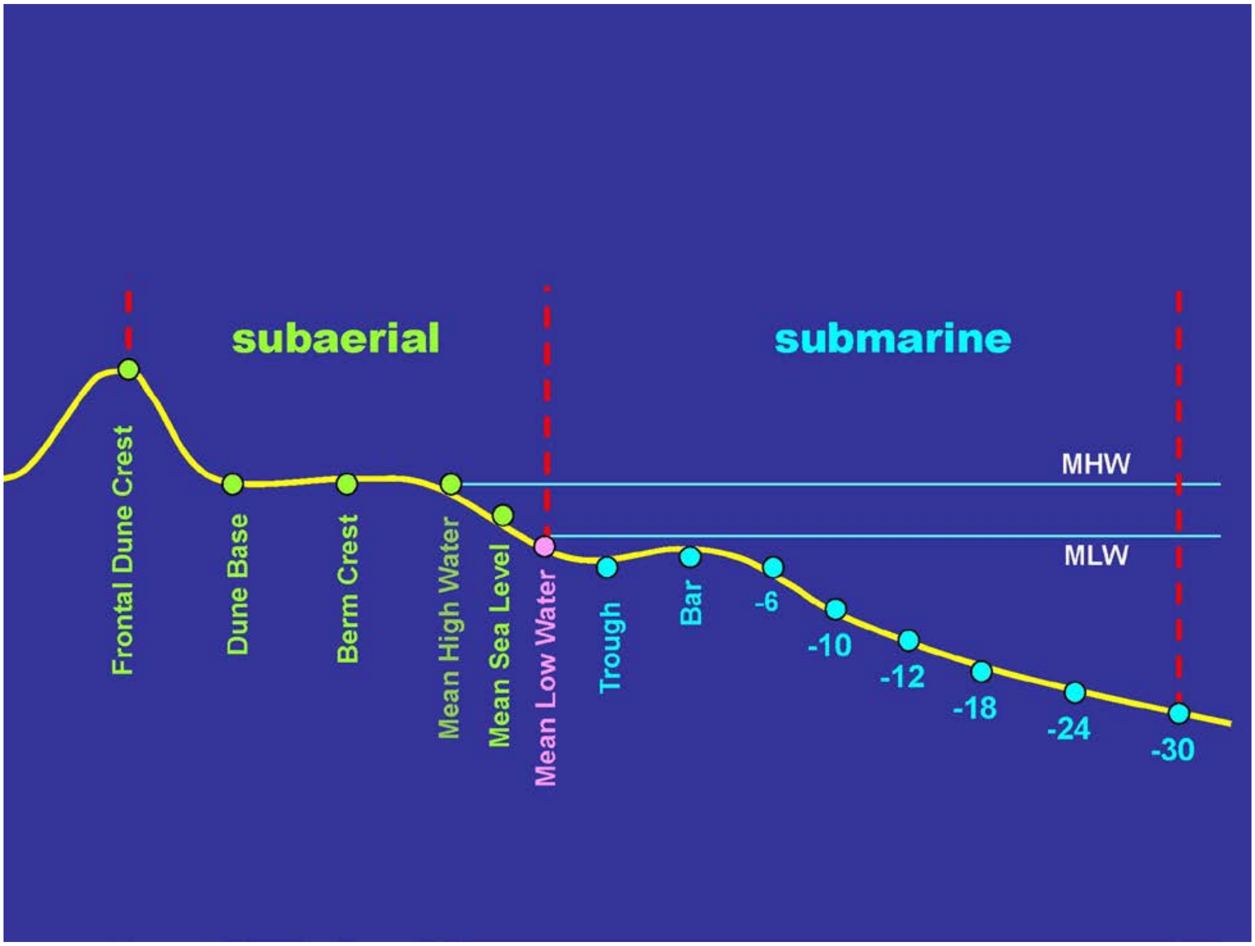


Figure 4-2. Grab Sample Locations Along Beach Transects (profiles) at Shackleford Banks Beach.

Morehead City Harbor Navigation Channel. Between 2005 and 2008, numerous vibracore borings were performed in the Morehead City Harbor Channel (Figure 4-3) to determine the characteristics of dredged materials (USACE 2008b). The Morehead City Harbor ranges where sediments were collected were Ranges A, B, C, and the Cutoff.

Borings designated MIH-05-V-# and MOB-05-V# were vibracore borings performed in 2005. Borings designated MHC-06- # are vibracore borings performed in 2006. These borings are located in Range C. Borings designated MHCOB-07-V-# are vibracore borings performed in 2007. Borings designated MHC-08-V-# are vibracore borings performed in 2008. These borings are located throughout the Morehead City Harbor channel from Range C to Range A. They represent the most comprehensive set of borings performed to date for the identification of material to be dredged. All borings were drilled to a depth below the dredging depth unless vibracore refusal was encountered. Vibracore refusal was defined as a penetration rate of less than 0.1 feet in 10 seconds. Sediment samples taken below the project depth were not included in the analyses.

In all, 130 sediment samples were collected for analyses as described below. All samples within the channel limits to overdepth were tested in accordance with ASTM D 422. The sieves typically used in the testing were the 3/4”, 3/8”, #4, #7, #10, #14, #18, #25, #35, #45, #60, #80, #120, #170, #200, and #230 sieves. Hydrometer analyses were not performed on materials passing the #230 sieve.

The color of the sediment from the Morehead City Harbor channel was not documented to a standard test procedure. However, during the winter of 2010 and 2011, dredged sediment from the Morehead City Outer Harbor was placed on the beaches of Fort Macon State Park and the Town of Atlantic Beach. In April 2011, Wilmington District staff walked the beach placement areas and determined the color of the sediment by using the Munsell Color System. Eighteen (18) transects were sampled from Fort Macon State Park to the circle in the Town of Atlantic Beach. Spacing between transects was about 1,000 feet and 3 dry sediment samples per transect (from the mean high water contour, berm crest, and toe of dune) were color coded.

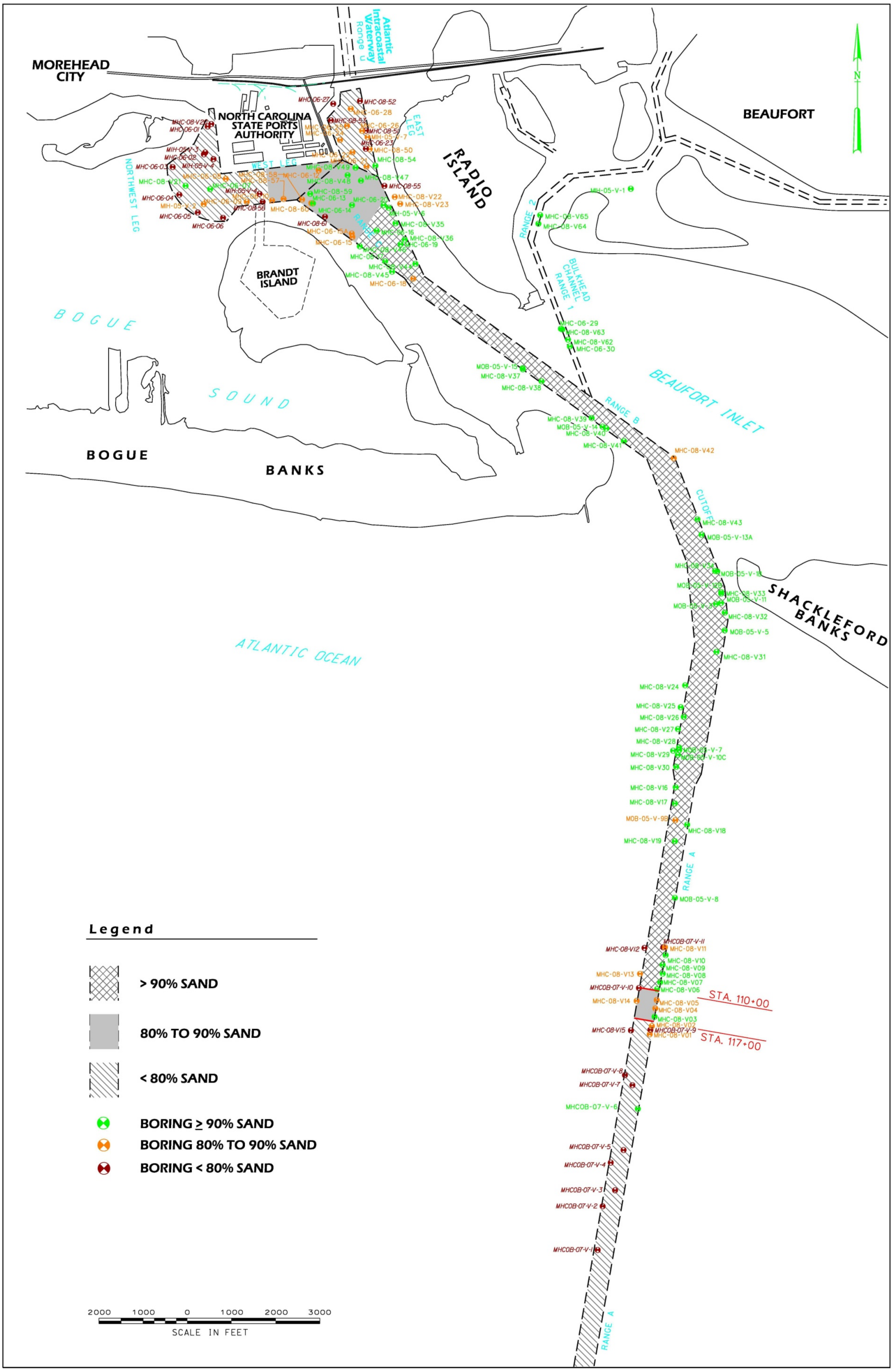


Figure 4-3. Morehead City Harbor Channel Sediment Characterization Boring Locations

Bogue Banks Beaches. During the summer of 2002, the Wilmington District characterized the beach sediment on Bogue Banks (USACE 2002b). A total of 525 sediment samples were taken (150 from the beach and 375 from the nearshore area to a depth of -24 feet) along 25 transects from Beaufort to Bogue Inlets (Figure 4-4). Spacing between transects was about 1 mile; there were 2 transects in Fort Macon State Park, 5 transects in Atlantic Beach, 6 transects in Pine Knoll Shores, 2 transects in Indian Beach/Salter Path, 7 transects in Emerald Isle, and 3 transects in the Bogue Inlet area.

In the foreshore area or beach area, six surface samples were collected from each of the 25 transect lines for a total of 150 samples. For each transect, one grab sample was collected from each of the following six locations:

1) seaward toe of the dune (DB);
2) crest of the berm (BC) approximately at elevation +7 NGDV;
3) mean high water (MHW), approximately at elevation +2.2 NGVD;
4) mean sea level (MSL), approximately +0.35 ft NGVD;
5) mean low water (MLW), approximately elevation -1.5 NGVD; and
6) at -3 NGDV.

The samples were collected from the top one to four inches of beach surface.

In the ocean, an average of 15 samples was collected from each of the 25 transect lines for a total of 375 samples. For each transect, one grab sample was taken at 2-foot increments of elevation beginning at elevation -4 NGVD through elevation -24 NGVD. The extra samples account for undulations of the ocean bottom. The samples were collected from the top one to four inches of ocean bottom.

All samples within the channel limits were tested in accordance with ASTM D 422. The hydrometer portion for the test procedure D 422 was not required for the material passing the Number 230 sieve. Classification of the samples was performed in accordance with ASTM D 2487. The sieves typically used in the testing were the 3/4", 3/8", #4, #7, #10, #14, #18, #25, #35, #45, #60, #80, #120, #170, #200, and #230 sieves.

The percent shell content of each sample was determined by estimating visually the amount of shell on each sieve, during the sieve procedure, to determine the overall sample shell content. Sediment color of these samples was not documented.

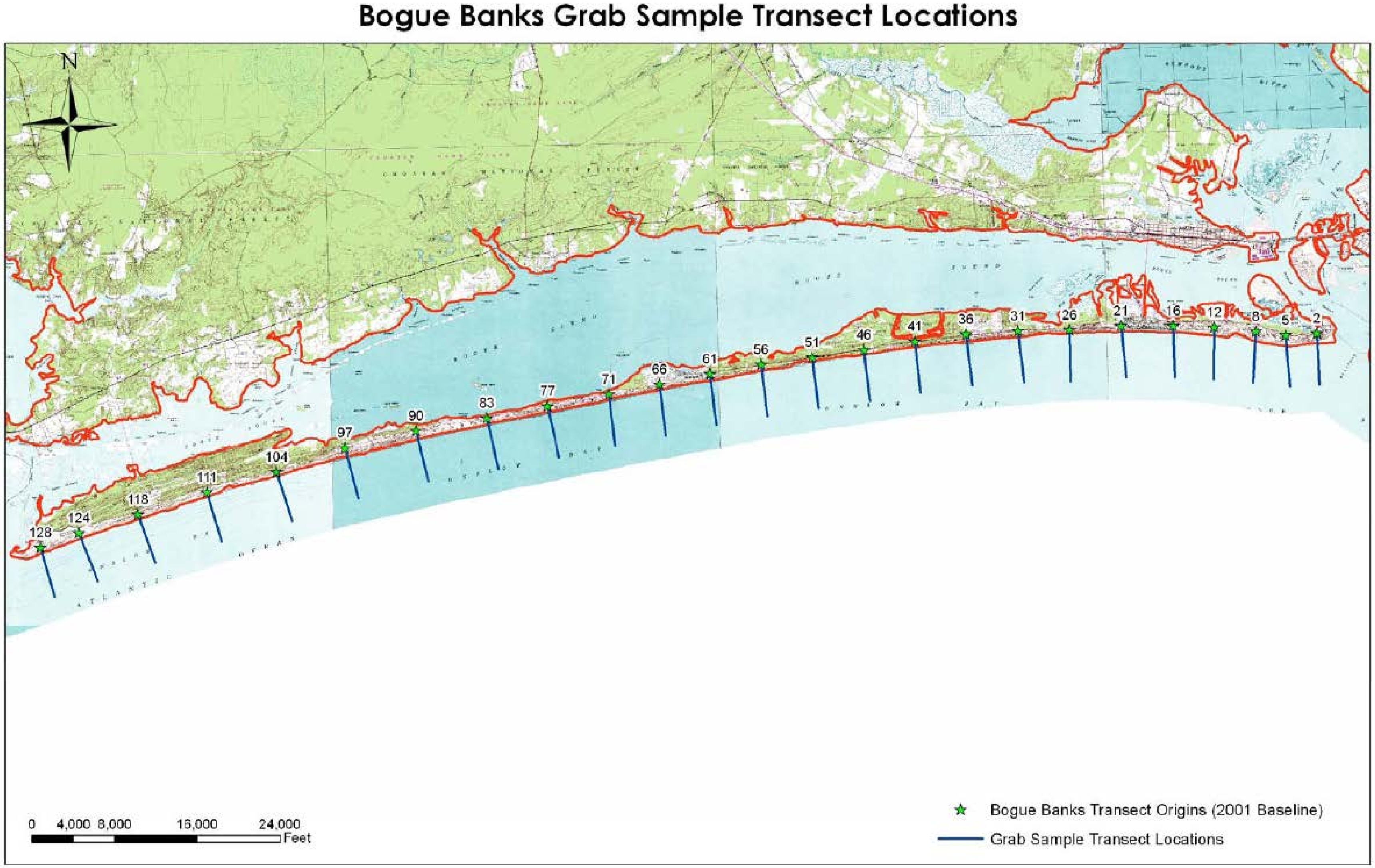


Figure 4-4. Bogue Banks Grab Sample Transect Locations

<u>Grain Size Analysis</u>. This section addresses grain size analyses and is summarized from the following sources: USACE 2002b, USACE 2008b, and USACE 2011.

Shackleford Banks. The 644 Shackleford Banks sediment samples collected illustrate the differences between the size-frequency distributions of sands from different zones on the beach. Grain size and sorting are useful parameters in explaining beach processes. The "beach" is a highly dynamic environment that is affected by a variety of forces including longshore currents, waves, wind, and offshore currents.

Table 4-1 divides the Shackleford sediments into broad zones: the dune to a depth of -24 ft offshore (the approximate depth of closure to wave impact); the dune base to -24 ft; the dune base to MLW; and the beach trough to -24 ft. All 644 grain size analyses were averaged after sorting into these data classes. The mean grain size ranged from 0.532 mm (dune base to MLW) to 0.250 mm (TR (trough) to -24 ft). The percent fines (passing the # 200 sieve (<0.074mm) was less than 2.0% for all data classes. The percent visual shell ranged from 8% for TR to -24 ft to 22% for DB to MLW. The Shackleford grain size frequency distributions summarized in Table 4-1 and are shown graphically in Figure 4-5. The distributions are unimodal.

Table 4-2 and Figure 4-6 present grain size data for Shackleford Banks native beach sediments summarized as a location mean from the 46 transects. Three groups of mean grain sizes are evident. The upper or mainly dry beach has grain sizes in the 0.300 to 0.360 mm range. The wet beach (MHW to the TR), with the sweeping oscillatory motion of the water in the breaker zone, has higher mean grain size (0.529 to 0.888 mm). Farther offshore (TR to – 30 ft) the mean grain size is smaller (0.167 to 0.261 mm). These data show a relationship between size frequency distribution of sands and the energy of specific portions of the beach. The percent visual shell results for Shackleford (Table 4-2) shows a direct relationship with mean grain size (mm). The shell content distribution is also a function of the environmental conditions at those locations on the beach profile. Another parameter provided in Table 4- 2 is the standard deviation in phi units. This indicates the degree of sorting in the sediments. Shackleford sediments are very well sorted on the dry beach, the dune (DN) to the berm crest (BC). The sediments in the more energetic wave area (MHW to TR) are only moderately well sorted (meaning the grain size distributions are less uniform – more varied). They become very well sorted again farther offshore (Bar to – 30 ft offshore).

Morehead City Harbor Dredged Material. Table 4-1 provides the mean grain size for 130 samples taken between 2005 and 2008 from cores of shoaled sediments within the authorized navigation channel. These cores were taken in areas that are acceptable for beach disposal. The mean grain size of the Morehead City Harbor dredged material composite was 0.267 mm. The percent fines (passing the # 200 sieve (<0.074mm) was 3.6%. The percent visual shell was 16%. The Morehead City Harbor dredged material composite grain size frequency distribution is shown graphically in Figure 4-5.

Bogue Banks. Table 4-1 presents results of sediment samples collected along Bogue Banks beach transects. The samples were collected at six locations along each transect. The locations were slightly different than those collected for Shackleford and did not include locations farther offshore (i.e., -6 to -30 ft NGVD). For comparison, the nearest representatives to the Bogue transect locations in the Shackleford data are the DB to -24 ft NGVD sample statistics.

The mean grain sizes for Bogue Banks ranged from 0.183 mm (Atlantic Beach) to 0.213 mm (Fort Macon). The percent fines (passing the # 200 sieve (<0.074mm) ranged from 1.6% to 3.6%. The percent visual shell estimates ranged from 4% to 10.9% for the Bogue Banks transect locations.

Sediment	No. of Samples	Mean mm	Std Dev phi	% Passing #200 sieve (0.074mm)	%Visual Shell
Morehead City Outer Harbor Channel*	130	0.267	0.84	3.6	16.0
Shackleford Banks DN to -24 ft	598	0.339	1.13	1.2	13.0
Shackleford Banks DB to -24 ft	552	0.344	1.20	1.3	13.9
Shackleford Banks DB to MLW	230	0.532	1.29	0.4	22.2
Shackleford Banks TR to -24 ft	322	0.25	0.88	1.9	8.0
Fort Macon	34	0.213	0.80	1.6	10.9
Atlantic Beach	82	0.183	0.79	3.4	7.1
Pine Knoll Shores	102	0.188	0.81	3.6	8.9
Indian Beach	34	0.205	0.93	3.2	10.9
East Emerald Isle	47	0.203	0.74	2.6	6.3
West Emerald Isle	67	0.193	0.68	2.4	4.9
Bogue Inlet Area	51	0.189	0.52	1.9	4.0

Table 4-1. Grain Size Comparison for the Morehead City Harbor Maintenance Sediment, Bogue Banks Sediment and Shackleford Banks Native Sediments. All sediment data taken from USACE 2002b, USACE 2008b, and USACE 2011. * Note: The Morehead City Outer Harbor Channel is a weighted average of the sediment samples.

		Average for all Transects			
Location on Shackleford Beach	**No of Transects**	**phi**	**mm**	**Std (phi)**	**% Visual Shell**
Dune (DN)	46	1.707	0.306	0.239	1.8
Dune Base (DB)	46	1.565	0.338	0.273	3.7
Berm Crest (BC)	46	1.479	0.359	0.313	5.7
Mean High Water (MHW)	46	0.711	0.611	0.612	26.5
Mean Sea Level (MSL)	46	0.179	0.883	0.725	39.5
Mean Low Water (MLW)	46	0.459	0.727	0.688	35.2
Trough (TR)	46	0.917	0.529	0.639	23.7
Bar (BR)	46	1.966	0.256	0.313	4.7
-6 NGVD	46	1.938	0.261	0.344	6.2
-10 NGVD	46	2.100	0.233	0.283	3.9
-12 NGVD	46	2.178	0.221	0.266	4.6
-18 NGVD	46	2.327	0.199	0.295	5.2
-24 NGVD	46	2.190	0.219	0.383	7.9
-30 NGVD	46	2.580	0.167	0.318	3.9

Sorting (from inclusive graphic standard deviation)	
very well sorted	under 0.35 phi
well sorted	0.35 to 0.50 phi
moderately well sorted	0.50 to 0.71 phi
moderately sorted	0.71 to 1.0 phi

Table 4-2. Summary of the Grain Size Data for Shackleford Banks Sediments Sorted by Position on Transect. All sediment data taken from USACE 2011.

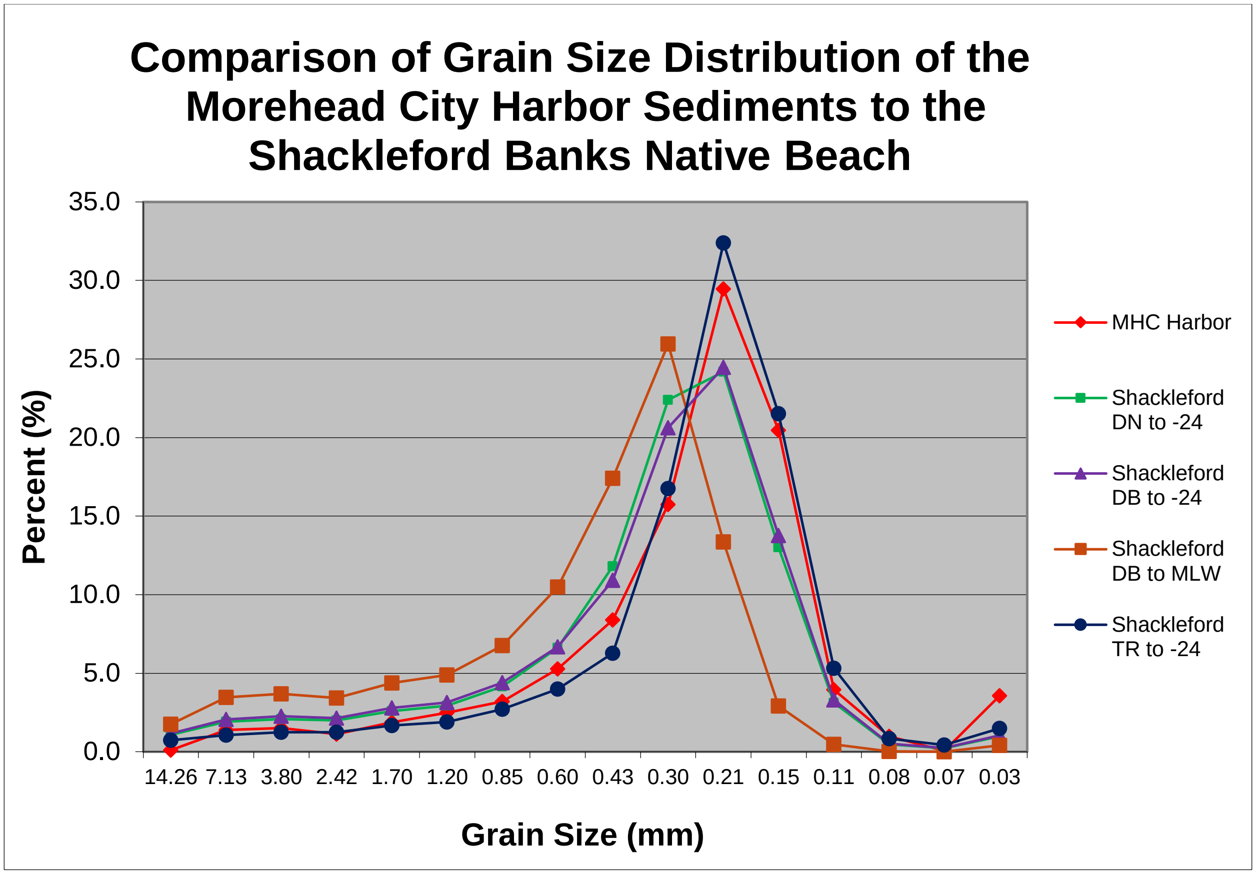


Figure 4-5. Grain Size Frequency Distribution - Shackleford Sediments Compared to the Dredged Material Composite Grain Size Frequency Distribution**.** Sediments from Shackleford collected May 2011 (USACE 2011) Distributions shown for Shackleford Banks are a composite (average) of 46 transects grouped by the locations on the beach profiles as shown. The distribution shown for Morehead City Harbor was obtained from 130 samples taken between 2005 and 2008 from cores of shoaled sediments within the authorized navigation channel.

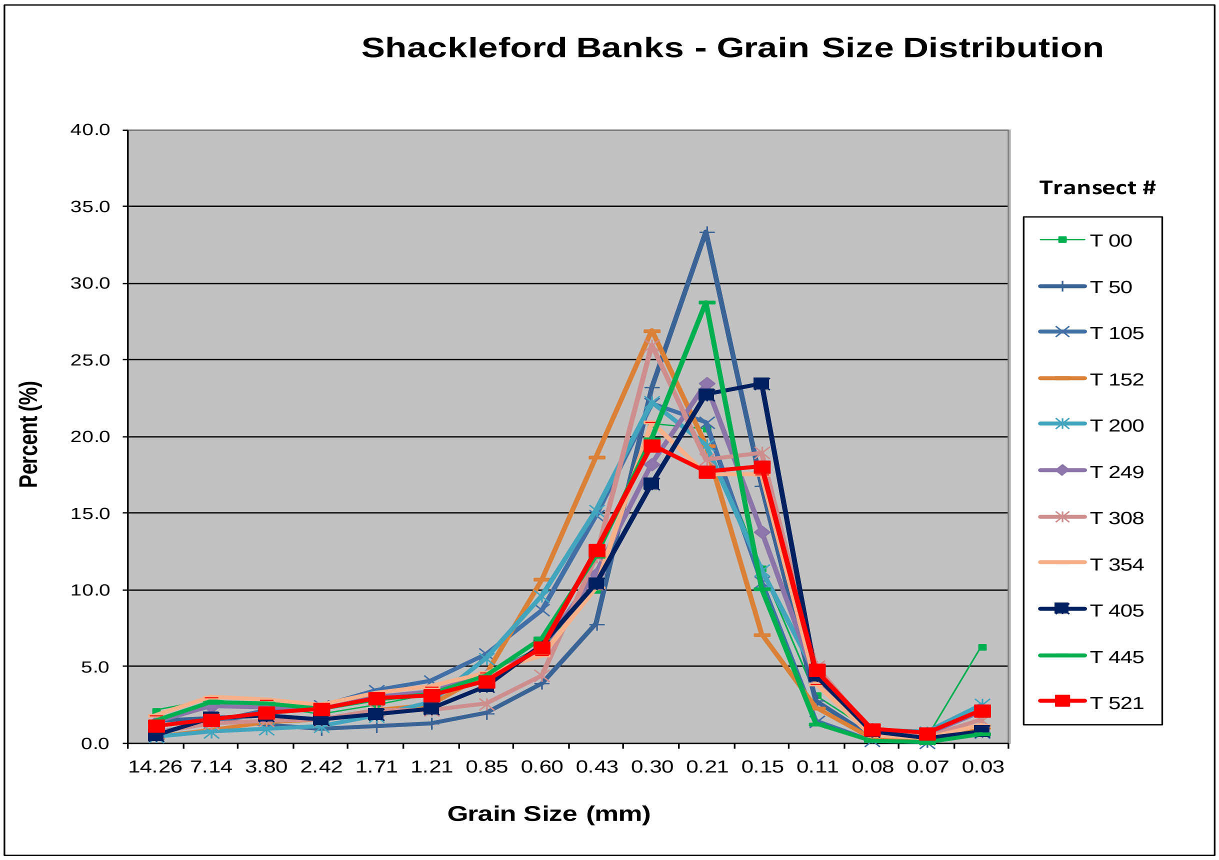


Figure 4-6. Grain Size Frequency Distribution of Shackleford Banks Sediments Collected May 2011 (USACE 2011). Distributions shown are composites or averages of all samples from the indicated transects which are spaced across the Shackleford Banks beach.

Sediment Color Analysis. The sediment color from the mean high water contour to the dune on Shackleford Banks (USACE 2011) along 46 transects was compiled and the color of the recently-dredged maintenance sediment from the federal navigation channel placed on Bogue Banks at Fort Macon and Atlantic Beach (April 2011 site visit) was also determined from the mean high water contour to the bottom of the dune.

Table 4-3 summarizes these results and compares the color of the existing upland Shackleford Banks Beach to the sediment from the Morehead City Outer Harbor (Ranges A and B (including south Range C) and the Cutoff) that was recently placed (winter of 2011) along Fort Macon and Atlantic Beach.

All color sediment samples were identified using the "*Munsell Color System*". For example, Munsell defines **10 YR 7/2** as the following:

> 1. 10 YR is the hue or yellow red in this case (Munsell defines hue as "*the quality by which we distinguish one color from another*" and according to Munsell "*there are five principle colors: red, yellow, green, blue, and purple; and five intermediate colors: yellow-red, green-yellow, blue-green, purple-blue, and red-purple*"),

2. 7 is the value (i.e., lightness or brightness from 10 equals absolute white to 0 equals absolute black), and

3. /2 is the chroma or the difference from a pure hue to a gray shade (i.e., higher numbers represent stronger chromas or hues and lower numbers are grayer in color).

Shackleford Banks. Table 4-3, below, summarizes these results and compares the color of the existing upper Shackleford Banks beach (DN to MHW). The majority of the samples (172 out of 187) were 2.5Y 7/2 and 2.5Y 7/1.

Bogue Banks. The color of the recently dredged maintenance sediment from the Morehead City Harbor navigation channel placed on Bogue Banks (April 2011 site visit) is presented in Table 4-3. The dredged material placed on Bogue Banks was mostly 10 YR 7/1 and 10 YR 8/1.

As shown in Table 4-3 below, the predominant color of the upland Shackleford Banks beach (mean high water contour to the dune) is <u>2.5 Y 7/2</u> and the recently placed Harbor dredged sediment on Bogue Banks is predominantly <u>10 YR 8/1</u>. The difference between the 10 YR and 2.5 Y hues is that the 10 YR is slightly redder in color than the 2.5 Y. This means that the dredged maintenance sediment from the Harbor was slightly redder than the native Shackleford Banks sediment. Or the native Shackleford Banks beach was slightly more yellow in color than the sediment from Morehead City Harbor.

The value (i.e., brightness/lightness of the sediment) of the native Shackleford beach (7) was slightly darker than the dredged sediment (8) from Bogue Banks (from the Morehead City Harbor navigation channels), or the Bogue Banks sediment is slightly lighter (8 vs. 7) than the native Shackleford Banks beach.

The chroma of the dredged material (/1) placed on Bogue Banks was slightly grayer than the native Shackleford Banks beach (/2).

Shackleford Banks Beach Color (Overwash Area (OW) and Top of Dune (DN) to MHW line)

Hue	Value	Chroma	Number of Samples with this Munsell Color	% of Total Samples
10 YR	6	1	2	1%
10 YR	7	2	8	4%
2.5 Y	7	1	32	17%
2.5 Y	7	2	140	75%
2.5 Y	7	3	5	3%

Total samples measured 187

(includes 3 OW samples from transects 190, 415, and 435)

Fort Macon and Atlantic Beach Color (Dune Base (DB) to MHW line)

Hue	Value	Chroma	Number of Samples with this Munsell Color	% of Total Samples
10 YR	7	1	15	28%
10 YR	8	1	26	48%
10 YR	8	2	11	20%
10 YR	8	3	2	4%

Total Samples measured 54

Table 4-3. Munsell Color of Sediments from the Beaches of Shackleford Banks and Fort Macon State Park/Town of Atlantic Beach. Data taken from USACE (2011) and site visit dated April 2011 to Fort Macon State Park and the Town of Atlantic Beach.

The sediment color from the mean high water contour to the dune on Shackleford Banks (USACE 2011) along 46 transects was compiled and the color of the recently dredged material from the federal navigation channel placed on Bogue Banks (April 2011 site visit) was also measured. Table 4-3 summarizes these results and compares the color of the existing upland Shackleford Banks beach to the sediment from the Morehead City Outer Harbor (Ranges A and B (including South Range C) and the Cutoff) that was recently placed (winter of 2011) along Fort Macon and Atlantic Beach.

4.1.3 Sediment Composition in the Nearshore Placement Areas

In 2009, sediment grain size grab samples were taken at 96 locations within the existing Nearshore Placement Area off Bogue Banks (Nearshore West) and the proposed nearshore area off of Shackleford Banks (Nearshore East). The purpose of this work was to characterize sediment particle size in these areas (USACE 2010b). Figure 4-7 shows the sediment sample locations off Bogue and Shackleford Banks.

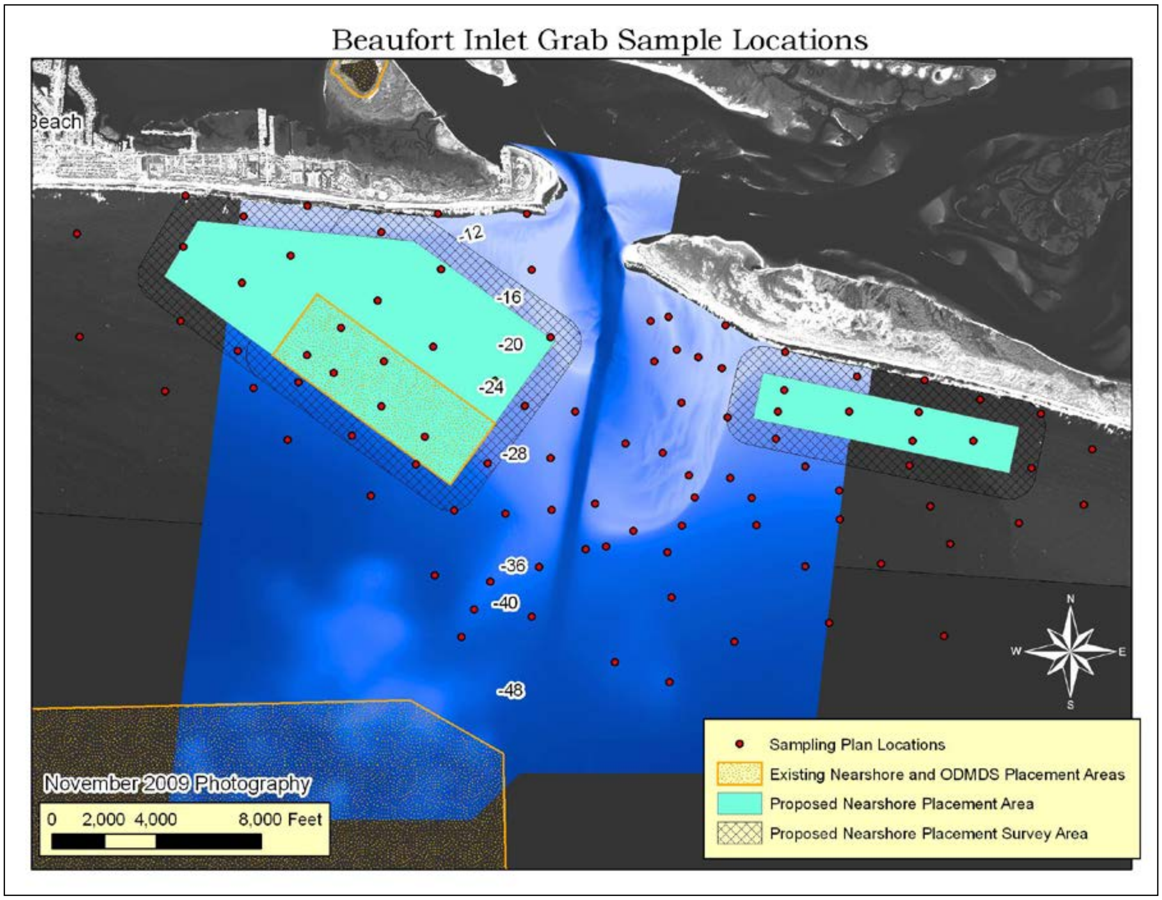


Figure 4-7. Sediment Sample Locations off Bogue Banks and Shackleford Banks

Out of the 96 sites sampled, 21.8% of the sites contained 10.3% to 61.0% silt/clay, and 42.7% had a low silt/clay content (<2% silt/clay). Areas of high silt/clay content (>10% and <61.0%) were found with one large group of sites occurring principally offshore of Shackleford Banks and several smaller areas offshore of Bogue Banks, in water depths ranging from ~20 to 49 feet. Areas of low silt/clay content (less than <2% silt/clay content) predominantly were found along the ebb tide delta and along the nearshore of Bogue and Shackleford Banks. A grouping of these stations also occurs offshore in ~40 feet of water. Three large groups of medium silt/clay content (>2 and <10% silt/clay content) occurred in the mid to nearshore of Shackleford Banks, offshore of the ebb tide delta, and in the mid to nearshore of Bogue Banks.

4.1.4 Sediment Contaminants

The Morehead City Harbor channel sediments that are coarse-grained are not likely to contain unacceptable levels of contaminants. These sediments meet the 40 CFR Section 227.13(b) criteria for compliance with the EPA Ocean Dumping Regulations and Criteria without further testing. The Morehead City Inner Harbor sediments that have significant silt and clay components do not meet Part 227.13(b) criteria for exclusion from further evaluation. Those sediments have been evaluated to determine acceptability for ocean disposal in accordance with EPA's Ocean Dumping Regulations and Criteria. The evaluations included Water Column (Section 227.6(c)(1) and 227.27(a)), Suspended Particulate Phase (Section 227.6(c)(2) and 227.27(b), and Benthic (Section 227.6(c)(2) and 227.27(b)) determinations.

Specific testing methods are described in Evaluation of Dredged Material Proposed for Ocean Disposal Testing Manual (USEPA/USACE 1991), hereafter referred to as the 1991 Implementation Manual (or Green Book) and the Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. – Testing Manual, Inland Testing Manual (USACE/EPA 1998), hereafter referred to as the Inland Testing Manual (ITM). In addition, the Southeastern Regional Implementation Manual, Requirements and Procedures for Evaluation of the Ocean Disposal of Dredged Material in Southeastern U.S., Atlantic and Gulf Coastal Waters (USEPA/USACE 2008) provides further guidance on procedures to be followed when assessing the suitability of dredged material for ocean disposal. The testing manuals provide guidance to support the tiered-testing procedure for evaluating compliance.

The sampling design was closely coordinated with EPA, Region IV and included bulk sediment analyses, bioassays, and bioaccumulation evaluations. The results of these sediment evaluations are reported in *Evaluation of Dredged Material Proposed for Ocean Disposal, Morehead City Inner Harbor and USCG Station Fort Macon, North Carolina, September 2006* (USACE 2006). The test results indicate that the dredged materials resulting from dredging in the tested Morehead City Inner Harbor areas are acceptable for ocean disposal under Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972, as amended. This means that the sediments do not contain prohibited constituents other than trace contaminants. The USEPA, Region 4 has concurred with all previous Section 103 evaluations. Periodic re-evaluations will be performed as required by EPA and USACE policy.

4.2 Hazardous and Toxic Waste

The North Carolina State Ports Authority (NCSPA 2001) reviewed information, published by the United States Environmental Protection Agency (EPA), the North Carolina Department of Environment and Natural Resources (NCDENR; now NC Department of Environmental Quality (NCDEQ)), and E Data Resources, Inc. (EDR) (an environmental database search firm). This review was used to determine if any known sites producing, storing, and/or disposing of toxic or hazardous materials have affected or have the potential to affect the Morehead City Harbor project area.

The EDR database search (EDR 2010) identified one site on Radio Island where a leaking underground storage tank (UST) was located. Two 1,000 gallon USTs were removed from the site in 1992. The tanks, which contained gasoline, had leaked, contaminating both the soil and groundwater. Contaminated soils were removed during excavation of the tanks. The NCDEQ records show that another 4,000 gallon gasoline UST, on Radio Island was removed in December, 1993. Possible petroleum contamination was observed in the soil around the tank. In March 1994 a monitoring well was installed in the tank excavation area and a groundwater sample obtained. However, the sample was below detectable limits for targeted petroleum related compounds.

Groundwater contamination is also documented at the site of the former Aviation Fuel Terminals, Inc. (AFT) facility on Radio Island. The AFT owned and operated a liquid bulk storage and handling facility for JP-4 and JP-5 jet fuels from 1953 to 1997. Aviation Fuel Terminal's contracts for fuel storage ended in May 1997 and ten of the above-ground storage tanks (ASTs) have been empty since that time. The remaining 6 ASTs include 3 liquid fertilizer tanks, 2 liquid sulfur tanks and 1 sulfuric acid tank.

Jet fuel contamination associated with past practices at the tank farm and loading rack was discovered in 1999 during a Phase II Site Assessment. This was followed by the preparation of a Comprehensive Site Assessment Report (CSA) in July 1999. At present there are 54 on-site and 7 off-site groundwater monitoring wells. The CSA reported that petroleum related compounds had been detected in both soil and shallow groundwater.

Three Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) sites are within a four-mile radius of the Morehead City Harbor port facility center (EDR 2010). The file information found for these sites was cursory with no activities initiated by the NC Superfund or the Inactive Hazardous Sites Branch within the past eight years. The US Coast Guard Fort Macon Station (NC5690308262) is located at Atlantic Beach, 0.6 miles south of Radio Island. It was removed from the CERCLIS list and the Inactive Hazardous Sites Branch gave it a status of No Further Action. The National Marine Fisheries Service (NC3131430180) is located in Beaufort on Pivers Island Road, 0.5 miles east of the project site. It has a status of No Further Remedial Action Planned under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and No Further Action status under the State's Inactive Hazardous Sites Branch. The US Army Reserve XVIII Airborne Corps (NC5210022906) on Fisher Street in Morehead City is 1.1 miles northeast of the project. It has a federal status of No Further Remedial Action Planned and No Further Action under the State's Inactive Hazardous Sites Branch.

4.3 Water Resources

4.3.1 Water Quality

Sensitive aquatic systems within the Morehead City Harbor project area (Atlantic Ocean, Newport River, Bogue Sound, and Back Sound around Cape Lookout National Seashore) that may be affected by water quality include submerged aquatic vegetation and associated fauna, marshes, and nektonic communities (fish, shellfish, and marine reptiles and mammals). The following section describes existing water quality conditions that have a direct impact on these aquatic systems.

Morehead City Harbor is located within the confluence of the Newport River and Bogue Sound. Tides are semi-diurnal (two tidal cycles per day), and the average tidal range from mean high to mean low in Morehead City Harbor is about 3.1 feet (NOAA 2011).

Salinity concentrations in the navigation channel through Beaufort Inlet are near sea strength (Salinity greater than 34 parts per thousand) and range from 29.0 parts per thousand (ppt) to 34.5 ppt depending on the sample location, tidal cycle and freshwater discharge (Churchill et al. 1999).

The Newport River watershed (subbasin 03-05-03) is located just east of the White Oak River. It flows into the eastern end of Bogue Sound before entering the Atlantic Ocean near Morehead City. There are 74 stream miles, 34,445 estuarine acres and 25 miles of Atlantic coastline in this subbasin (NCDENR 2007).

Bogue Sound is the body of shallow water to the north of Bogue Banks, separating the barrier island from the mainland of Carteret County. The Sound is bordered by Bogue Inlet and the White Oak River to the west and Beaufort Inlet and the Newport River to the east. The Atlantic Intracoastal Waterway (AIWW) traverses the northern portion of Bogue Sound in an east-west orientation. Salinity varies in the Sound, with the highest levels (about 34 ppt) closest to the two inlets where the tidal influence is strongest. The North Carolina Division of Water Resources (NCDWR) has designated Bogue Sound as having Outstanding Resource Waters (ORW) due to their high quality.

Bogue Sound also provides diverse aquatic resources. Over 6100 acres of SAV were located in the sound in 1988 or 1993 (NOAA 2002). These beds have been designated as Essential Fish Habitat (EFH) by the South Atlantic Fishery Management Council (SAFMC) for their high value to blue crab (*Callinectes sapidus*), juvenile fish, and shrimp (*Penaeus* sp.). All five species of sea turtles found in North Carolina waters (Epperly et al. 1995) and the West Indian manatee (*Trichechus manatus*), all federally-protected species, may forage in Bogue Sound during warmer summer months. As herbivorous and/or omnivorous species, these aquatic species forage upon SAV beds for nourishment.

The sound is of moderate size for North Carolina (with a maximum fetch of ~23 miles), larger than any open-water sound to the south but covering less area than Albemarle or

Pamlico Sounds to the north (which have maximum fetches of 30-70 miles). The southern portion of the sound along Bogue Banks contains several areas of sand shoals and *Spartina* spp. marsh. Shellfish beds and submerged aquatic vegetation (SAV) occur throughout the sound. Comparatively deeper waters allow navigational use and transport of larval stages of fishery resources.

Back Sound is part of the Albemarle-Pamlico (AP) estuary system, which is the second largest estuary in the United States, draining a watershed of approximately 30,000 square miles. The AP estuary encompasses over 9,000 miles of freshwater rivers and streams and over 1.5 million acres of brackish, estuarine waters. There are five major river basins (Chowan, Roanoke, Pasquotank, Tar-Pamlico, and Neuse) that flow into the Albemarle-Pamlico system.

Back Sound is very shallow in most areas adjacent to the CALO, averaging only 1 to 2 feet in depth at low tide. Tides are semi-diurnal (two tidal cycles per day), and the mean tidal range at Cape Lookout is 3.7 feet (NOAA 2005), so the maximum depth of park waters is approximately 6 feet. There are navigational channels through the Core and Back Sounds, but these channels are only 5 to 10 feet deep. High tidal flushing occurs around the Beaufort and Ocracoke Inlets because they exceed 20 feet in depth, allowing tidal currents to reach speeds up to four knots (NOAA 2005). With Barden Inlet only 10 feet deep and New Drum Inlet even shallower, the sound side of the North and South Core Banks has low tidal flushing.

The Albemarle-Pamlico estuary system has seasonal salinity cycles, with the highest salinity occurring from September to November, the lowest from February to April (NOAA no date). During periods of high salinity, waters adjacent to the national seashore in Core and Back Sounds can have a salinity greater than 25 parts per thousand (ppt). During low salinity periods, waters in Back Sound adjacent to the eastern half of Shackleford Banks and waters in Core Sound adjacent to North Core Banks have an average salinity of 15 to 25 ppt. Annual ocean water temperatures off the Outer Banks ranges from approximately 50° to 80°F (NOAA no date).

Core Sound is classified by the North Carolina Department of Environmental Quality, Division of Water Resources as High Quality Waters, a classification intended to protect waters with quality higher than State water quality standards. There are associated wastewater treatment and development controls for High Quality Waters enforced by the State. Core Sound is also designated as Outstanding Resource Waters, a classification intended to protect unique and special waters having excellent water quality and being of exceptional state or national ecological or recreational significance. No new or expanded wastewater discharges are allowed into Outstanding Resource Waters, and there are associated watershed stormwater controls enforced by the State.

Because the islands of Cape Lookout National Seashore are a mile or more from the mainland, and are undeveloped, the water quality has not been significantly impacted by human activities (NCDENR 2007). The primary pollution sources include mainland urban stormwater and agricultural runoff, effluent from sewage treatment plants and septic systems, recreational boating and marinas, and commercial shipping. Due to the proximity to the Intracoastal Waterway, Morehead City, and Beaufort, waters near Beaufort Inlet have heavy ship and boat traffic.

The Environmental Protection Agency has developed national recommended water quality criteria for priority pollutants in ambient water for the protection of aquatic life and human health (EPA 2002). These criteria have been adopted as enforceable standards by most states. The Clean Water Act regulates and protects all national waters. Under this law all states must submit a 305(b) report, which characterizes the quality of their waters on a watershed level, and a 303(d) list, which establishes which specific water bodies do not meet the federal or state water quality standards for its designated use(s). The watersheds are rated as follows:

- Category I: Watersheds are in need of restoration and do not meet clean water and natural resource goals.
- Category II: Watersheds are meeting goals and may need action to maintain standards.
- Category III: Watersheds have pristine or sensitive aquatic conditions (most of these are designated as wilderness, wild and scenic rivers, or outstanding natural resource waters).
- Category IV: Watersheds do not have sufficient data to make an assessment.

The Clean Water Act requires that the surface waters of each state be classified according to designated uses. North Carolina's tidal salt waters are classified with the following categories:

- Class SC: Secondary Recreation and Aquatic Life Propagation
- Class SB: Primary Recreation plus SC uses
- Class SA: Shellfishing for Market Purposes plus SC/SB uses
- HQW: High Quality Water

If a waterbody does not meet the state designated use standards, it is considered impaired and is placed on the 303(d) list. North Carolina's 303(d) list of impaired waters includes the following within the study area: 1) the waters of the Newport River are impaired and closed to shellfish harvesting; 2) the waters of Core Sound are impaired due to fecal coliform bacteria with possible sources including septic systems, marinas, urban runoff, and agriculture; 3) the waters of Gales Creek are impaired and closed to shellfish harvesting; and 4) the waters of Back Sound are impaired and closed to shellfish harvesting (NCDENR 2012). Atlantic Ocean waters are listed as impaired due to a mercury fish advisory. Waters in Core Sound are Class SA, suitable for shellfishing for market purposes as well as primary and secondary recreation, and aquatic life propagation. All SA waters are by definition also High Quality Waters, and, as previously mentioned, Core Sound is designated as Outstanding Resource Waters because of its exceptional ecological significance. Table 4-4 summarizes the waterbody classifications in the project area.

Waterbody	Watershed	State Use Designation	303(d) Listed Impairment	Federal Designation: EPA Watershed Category
Newport River	White Oak River Basin (subbasin 03-05-03)	Class SA HQW	Fecal Coliform	Category II
Bogue Sound/Gales Creek	White Oak River Basin	Class SA HQW	Fecal Coliform	Category II
Back/Core Sounds	Bogue-Core Sounds (03020106)	Class SA	Fecal Coliform	Category II
Atlantic Ocean	Bogue-Core Sounds (03020106)	Class SB	Fish Advisory-Mercury	Category II

Table 4-4. Waterbody Classifications at Morehead City Harbor (NCDENR 2012, EPA 1998)

4.3.2 Groundwater

Groundwater on Bogue and Shackleford Banks occurs in an unconfined sand aquifer, an upper confined aquifer, and a lower confined aquifer. The unconfined aquifer (freshwater lens) in areas occupied by dunes will yield as much as 30 gallons per minute of freshwater to a horizontal well. In other parts of the seashore this aquifer is subject to periodic overwash from the ocean, thus temporarily contaminating it with saltwater. Some high dunes on Shackleford Banks and Bogue Banks offer some protection from overwash to the unconfined aquifer. Any lowering of the water table will cause a rise of the saltwater/freshwater interface. The upper confined aquifer, which occurs between depths of about 90 to 150 feet, is known to contain freshwater only in the New Drum Inlet area and at Harkers Island. The potential yield of this aquifer is unknown, but probably does not exceed 10 to 15 gallons per minute (NCDENR 2007).

The lower confined aquifer, which occurs between depths of 150 and 550 feet, contains freshwater. Potential yield is estimated to be as much as 500 gallons per minute per well. The estimated freshwater yield from all aquifers depends on the position of the saltwater interface at any site. Water samples from the seashore generally meet drinking water standards set by the U. S. Environmental Protection Agency although some samples contained excess concentrations of chloride, iron, and manganese. Excessive chloride in the area is indicative of the presence of saltwater. Excessive iron and manganese occur naturally in some groundwater and may also be dissolved from well casings or pumping equipment (NCDENR 2007).

Groundwater is plentiful throughout the County. It is near the surface in most places, particularly during the winter and early spring. Thousands of feet of sedimentary deposits underlie the area. The upper part of these deposits contains aquifers that supply water for domestic use. The surficial aquifer ranges from near the surface to a maximum depth of 75 feet. It is thickest east of Morehead City. Early in the development of the County, the main source of domestic water was from shallow wells in this aquifer. The use of shallow wells has decreased considerably because of the small yield in some places, the high content of dissolved iron in the water, and the risk of contamination. The underlying limestone of the Yorktown or Castle Hayne Formations, or both, is a more productive artesian aquifer and is the main source of water supply in the County today. The water is generally hard, but low in iron. Water from wells near the coast and especially on the Outer Banks may be salty, but layers of fresh groundwater are at lower depths.

4.4 Air Quality

The Wilmington Regional Office of the North Carolina Department of Environmental Quality has air quality jurisdiction for the project area. The ambient air quality for Carteret County has been determined to be in compliance with the National Ambient Air Quality Standards, and this County is designated as an attainment area.

4.5 Marine and Estuarine Resources

4.5.1 Nekton

Nekton collectively refers to aquatic organisms capable of controlling their location through active movement rather than depending on water currents or gravity for passive movement. Nekton of the nearshore Atlantic Ocean along Bogue and Shackleford Banks, North Carolina, can be grouped into three categories: estuarine dependent species, permanent resident species, and seasonal migrant species. The most abundant nekton of these waters are the estuarine-dependent species, which inhabit the estuary as larvae and the ocean as juveniles or adults. That group includes species that spawn offshore, such as the Atlantic croaker (*Micropogon undulatus*), spot (*L. xanthurus*), Atlantic menhaden (*B. tyrannus*), star drum (*Stellifer lanceolatus*), southern kingfish (*Menticirrhus americanus*), flounders (*Paralichthys* spp.), mullets (*Mugil* spp.), anchovies (*Anchoa* spp.), blue crab (*Callinectes sapidus*), and penaeid shrimp (*Farfantepenaeus* spp. and *Lilopenaeus* sp.), as well as species that spawn in the estuary, such as red drum (*Sciaenops ocellatus*) and weakfish (*Cynoscion regalis*). Species that are permanent residents of the nearshore marine waters include the black sea bass (*Centropristis striata*), longspine porgy (*Stenotomus caprinus*), Atlantic bumper (*Chloroscombrus chrysurus*), inshore lizardfish (*Synodus foetens*), and searobins (*Prionotus* spp.). Common warm water migrant species include the bluefish (*Pomatomus saltatrix*), Spanish mackerel (*Scomberomorus maculatus*), king mackerel (*Scomberomorus cavalla*), cobia (*Rachycentron canadum*), Florida pompano (*T. carolinus*), and spiny dogfish (*Squalus acanthias*). Oceanic large nekton offshore of Bogue and Shackleford Banks are composed of a wide variety of bony fishes, sharks, and rays, as well as fewer numbers of marine mammals and reptiles.

4.5.2 Benthic Resources - Beach and Surf Zone

The intertidal zone of the beach shoreface is extremely dynamic and is characterized as the area from mean low tide landward to the high tide mark. Figure 4-8 shows a typical beach cross section for proposed beach disposal of maintenance dredged material. The intertidal zone serves as habitat for invertebrate communities adapted to the high-energy, sandy-beach environment. Important invertebrates of the surf zone and beach/dune community include the mole crab (*Emerita talpoida*), coquina clams (*Donax variabilis*), polychaete worms, amphipods, and ghost crabs (*Ocypode quadrata*). Mole crabs and coquinas represent the largest component of the total macrofaunal biomass of North Carolina intertidal beaches, and they are consumed in large numbers by important fish species such as flounders, pompanos, silversides, mullets, and kingfish (Reilly and Bellis 1978; Leber 1982; Johnson 1994). Beach intertidal macrofauna are also a seasonally important food source for numerous shorebird species.

Through recent studies supported by the U.S. Fish and Wildlife Service (USFWS) and the USACE, the distributions and abundance of these animals on nearby beaches is fairly well documented. Extensive sampling of the intertidal and nearshore beach environment was performed and documented in the USACE, New York District's biological monitoring report titled, *Final Report for The Army Corps of Engineers New York District's Biological Monitoring Program for the Atlantic Coast of New Jersey, Sea Bright to Manasquan Inlet, Beach Erosion Project* (USACE 2001a). Results of that study indicate that the intertidal infaunal assemblage was dominated by rhynchocoels; the polychaetes *Scolelepis squamata*, *Protodriloides (LPIL)*, and *Microphthalmus* spp.; oligochaetes; the mole crab *E. talpoida*; and a number of haustoriid amphipods. The nearshore infaunal assemblage included many of the same taxa but was dominated by the wedge clam, *D. variabilis*, the polychaete *Magelona papillicornis*, the clams *Spisula solidissim*a and *Tellina agilis,* and the amphipods *Acanthohaustorius millsi* and *Psammonyx nobilis*, and the polychaete *Asabellides oculata*. Those documented infaunal assemblages are consistent with other studies throughout the Atlantic Coast (USACE 2001a). In North Carolina, including the project area, infaunal assemblages are dominated by *D. variabilis*, *D. parvula*, and *E. talpoida*, which function as an important first link in the flow of energy in the intertidal system (Leber 1982; Reilly and Bellis 1978). Other organisms occurring less frequently are Amphipods (*Haustorius canadensis, Talorchestia megalopthalma*, and *Amphiporia virginiana*) and Polychaetes (*S. squamata* and *Nephtys picta*) (Lindquist and Manning 2001; Nelson 1989; Leber 1982; Reilly and Bellis 1978).

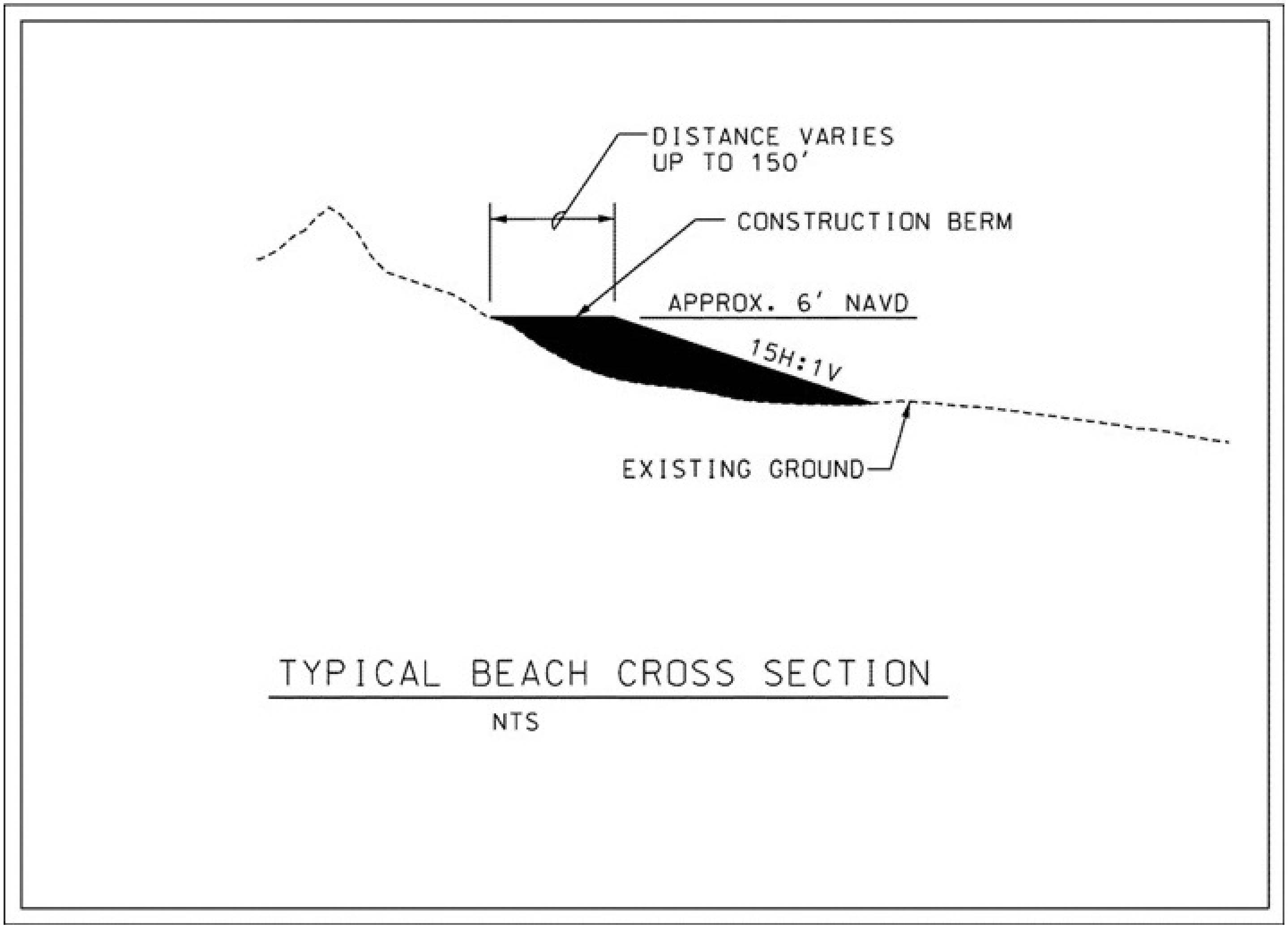


Figure 4-8. Typical Beach Cross Section from Dune Base to about -24 foot depth (Not to Scale).

4.5.3 Benthic Resources - Nearshore Ocean

The following is taken from the North Carolina Coastal Habitat Protection Plan (Deaton et al. 2010).

Offshore sand bottom communities along the North Carolina coast are relatively diverse habitats containing over a hundred polychaete taxa (Lindquist et al. 1994; Posey and Ambrose 1994). Tube dwellers and permanent burrow dwellers are important benthic prey for fish and epibenthic invertebrates. These species are also most susceptible to sediment deposition, turbidity, erosion, or changes in sediment structure associated with sand mining activities, compared to other more mobile polychaetes (Hackney et al. 1996). In South Carolina, 243 species of benthic invertebrates were documented in the nearshore subtidal bottom (Van Dolah et al. 1994). Polychaetes and amphipods were the most abundant, although oligochaetes, bivalves, and crabs were also highly represented (Van Dolah et al. 1994). On ebb tide deltas, polychaetes, crustaceans (primarily amphipods), and mollusks (primarily bivalves) were the most abundant infauna, while decapod crustaceans and echinoderms (sand dollars) dominated the epifauna. Because periodic storms can affect benthic communities along the Atlantic coast to a depth of about 115 ft (35 m), the soft bottom community tends to be dominated by opportunistic taxa that are adapted to recover relatively quickly from disturbance (Posey and Alphin 2001). Many faunal species documented on the ebb tide delta are important food sources for demersal predatory fishes and mobile crustaceans, including spot, croaker, weakfish, red drum, and penaeid shrimp. These fish species congregate in and around inlets during various times of the year (Peterson and Peterson 1979), presumably to enhance successful prey acquisition and reproduction.

Benthic communities approximately 2 miles inshore of the Morehead City ODMDS were sampled by Peterson and Wells (2000) as a part of the nearshore placement monitoring. The stations were arranged in a grid of three transects with three stations on each transect at the 19-, 26-, and 36-foot isobaths. Taxa in order of abundance included polychaetes, annelids, bivalve mollusks, amphipod crustaceans, echinoderms, and nematodes. The total density of infaunal invertebrates ranged from 5-14 per 76 cm^2 and total densities of larger epifaunal invertebrates ranged from 3 to 43 individuals per 10 m^2. This sampling is thought to be representative of those occupying this environment over a broad geographic area.

The USACE collected sediment and macroinvertebrate samples at 96 stations (Figure 4-7) in the vicinity of the Beaufort Inlet ebb tide delta in September 2009 (USACE 2010b). Benthic community characterizations and sieve analysis were performed on the sediment samples. A report was compiled describing the methods and results of biological and sediment sampling conducted at the 96 sample locations. The report includes (1) a description of macroinvertebrate community and sediment conditions, (2) a compilation of sediment and macroinvertebrate sampling results; and (3) spatial analyses of similarities and differences between sample sites. The report is summarized in the paragraphs which follow.

Benthic Community. A total of 7,053 organisms representing 260 taxa were identified from 95 samples. Polychaetes were the most numerous organisms, representing 43.9 percent of the total assemblage, followed by malacostracans (primarily amphipods) at 25.7 %, bivalves (10.5 %) and gastropods (10.0 %). The number of taxa per station ranged from 1 to 57. Station densities ranged from 9.1 organisms/m^2 to 4,609 organisms/m^2.

Similarity Determinations. Clustering of stations based on sediment and macroinvertebrate species populations and assemblages was evident through spatial analysis. The data suggest that the nearshore site showing the closest correlation and strongest relationships between sample sites is located offshore of Shackleford Banks. This area has medium silt/clay content and benthic species diversity and richness values are moderate to high. The shallow water depths cause the benthic environment to be influenced by scour and sediment resuspension caused by wave action and tidal currents.

4.5.4 Surf Zone Fishes

The surf zone along the area beaches provides important fishery habitat on which some species are dependent. Surf zone fisheries are typically diverse, and 47 species have been identified from North Carolina; however, the actual species richness of fishes using the North Carolina surf area for at least part of their life history is much higher (Ross 1996; Ross and Lancaster 1996). According to Ross (1996), the most common species in the South Atlantic Bight surf zone are Atlantic menhaden (*Brevoortia tyrannus*), striped anchovy (*Anchoa hepsetus*), bay anchovy (*A. mitchilli*), rough silverside (*Membras martinica*), Atlantic silverside (*Menidia menidia*), Florida pompano (*Trachinotus carolinus*), spot (*Leiostomus xanthurus*), Gulf kingfish (*Menticirrhus littoralis*), and striped mullet (*Mugil cephalus*). Two species in particular, the Florida pompano and gulf kingfish (*M. littoralis*) seem to use the surf zone exclusively as a juvenile nursery area and are rarely found elsewhere. The major recruitment time for juvenile fishes to surf zone nurseries is late spring through early summer (Hackney et al. 1996). Recent studies by Ross and Lancaster (1996) indicate that the Florida pompano and gulf kingfish may have high site fidelity to small areas of the beach and extended residence time in the surf zone, suggesting its function as a nursery area. Major surf zone species consume a variety of benthic and planktonic invertebrates, with most of the prey coming from the water column. The dominant benthic prey are coquina clams; however, that is not the dominant food item throughout the South Atlantic Bight. Furthermore, many surf zone fishes exhibit prey switching in relation to prey availability, which could mitigate effects of beach disposal (Ross 1996).

4.5.5 Larval Fishes

Beaufort Inlet is an important passageway for the larvae of many species of commercially or ecologically important fish. Spawning grounds for many marine fishes are believed to occur on the continental shelf with immigration to estuaries during the juvenile stage. The shelter provided by the marsh and creek systems in the sound serves as nursery habitat where young fish undergo rapid growth before returning to the offshore environment.

Transport from offshore shelves to estuarine nursery habitats occurs in three stages: offshore spawning grounds to nearshore, nearshore to the locality of an inlet or estuary mouth, and from the mouth into the estuary (Boehlert and Mundy 1988). Hettler et al. (1997) documented, through analysis of larvae otoliths, that a large number of young Atlantic menhaden (*B. tyrannus*) larvae averaging 55 days post-hatch arrived in mid-March on the date of maximum observed daily concentration (160 larvae per 100 cubic meters (m^3)(3,531 cubic feet [ft^3]). For all species recorded in this study, abundance varied as much as an order of magnitude from night to night. The methods the larvae use to traverse large distances over the open ocean and find inlets are uncertain. Various studies have hypothesized such mechanisms as passive wind and depth-varying current dispersal and active horizontal swimming transport. However, little is known regarding larval distribution in the nearshore area.

The Beaufort Inlet system has been extensively studied, and significant amounts of data have been collected regarding larval transport of commercially and ecologically important fish. During the winters of 1992–1993 and 1993–1994, Hettler and Hare (1998) conducted an experiment at Beaufort Inlet, North Carolina, to further understand the estuarine ingress of offshore spawning species. A complex lateral structure in estuarine circulation, independent of the inlet opening size, was found in regards to larval concentration with significant interactions among inlet side, distance offshore, and date of ichthyoplankton tows. Length of species caught varied by cruise, inlet side, and distance offshore. The differences in larval concentration offshore and inshore and the species differences in length suggest species-specific rates controlling the net number of larvae entering the nearshore from offshore, the net number of larvae entering the inlet mouth from nearshore, and the larval mortality in the nearshore zone. Results from the study suggest two bottlenecks for offshore-spawning fishes with estuarine juveniles: the transport of larvae into the nearshore zone and the transport of larvae into the estuary from the nearshore zone (Hettler and Hare 1998).

Egg and larval transport from offshore spawning grounds to the inshore environment of Beaufort Inlet was studied by Hettler and Hare (1998) in seven estuarine-dependent species, including Atlantic menhaden (*B. tyrannus*), spot (*L. xanthurus*), Atlantic croaker (*Micropogonias undulatus*), pinfish (*Lagodon rhomboides*), summer flounder (*Paralichthys dentatus*), southern flounder (*P. lethostigma*) and Gulf flounder *(P. albigutta*). Research conducted by the NMFS Beaufort Laboratory through June 2002 collected a total of 120 species of larval fish fauna off the Beaufort Inlet and adjacent waters. According to Hettler and Hare (1998), average weekly concentration (number per 100 m^3 (3,531 ft^3)) for all of the above estuarine dependent species, with the exception of Gulf flounder, was calculated during the October 1994 to April 1995 immigration season. Concentrations were 22.9, 4.8, 25.7, 12.4, 0.3, and 0.8 larvae/100m^3 (3,531 ft^3) respectively (Hettler 1998). According to the spring tide flow calculated by Jarrett (1976) and the calculated daily larval concentration within the water column, approximately 32.5, 6.8, 36.5, 17.6, 0.43, and 1.1 million larvae pass through the inlet during a single spring tide for each respective species. Concentrations for all species combined entering the inlet during a single tidal prism range from 0.5 to 5 larvae/m^3. Therefore, daily calculated larval concentration at Beaufort Inlet for all species within the tidal prism ranges between 66 to 710 million (Larry Settle, personal communication, June 27, 2002).

4.5.6 Hardbottoms

Of special concern in the offshore area are hardbottoms, which are localized areas, not covered by unconsolidated sediments and where the ocean floor is hard rock. Hardbottoms are also called "live bottoms" because they support a rich diversity of invertebrates such as corals, anemones, and sponges, which are refuges for fish and other marine life. They provide valuable habitat for reef fish such as black sea bass, red porgy, and groupers. Hardbottoms are also attractive to pelagic species such as king mackerel, amberjack, and cobia. Along the North Carolina coast, hard bottoms are most abundant in southern portion of the State. Review of data provided by the Southeast Monitoring and Assessment Program (SEAMAP 2001) and the results of surveys from Tidewater and Geo-Dynamics identified one area of hardbottom off Pine Knoll Shores, about 2 miles south of the project area.

To assess potential beach nourishment impacts from the Bogue Banks Shore Protection Project (BBSPP) to hardbottom resources in the nearshore environment off of Bogue Banks, North Carolina, the U.S. Army Corps of Engineers initiated ground-truthing investigations of potential hardbottom habitat within and adjacent to the project area (USACE 2009). The study area was located in the nearshore environment off Bogue Banks, North Carolina, between Bogue Inlet and Beaufort Inlet. Previously-conducted sidescan sonar surveys of this area identified possible seafloor morphology of interest between 250 feet and 2500 feet from shore and between the -5 to -30-foot NGVD water depth contours (Greenhorne and O'Mara, 2007). This area is located on and/or within the limits of the calculated -25-foot NVGD depth of closure identified for the BBSPP. To assess potential beach nourishment impacts to hardbottom resources, USACE required ground-truth investigations of potential hardbottom within and adjacent to the BBSPP.

Ground-truth verification was completed on January 21 and 22, 2009 (USACE 2009b). The ground-truthing surveys conducted during the course of this investigation inshore of the depth of closure found only fine sand where prior sidescan sonar interpretations suggested other seafloor morphologies of interest. The explanation for this discrepancy is that sand movement within the depth of closure along a beach profile is well established and can be proven to have occurred through an examination of historic beach profiles. Although it is logical to assume sand movement inside the depth of closure, which is documented, it is the conclusion of this investigation that no hardbottom resources are present within the area surveyed by Geodynamics (Greenhorne and O'Mara, 2007). This conclusion is based on four primary factors:

(1) A re-analysis and interpretation of sidescan sonar data concluded that no signatures indicative of hardbottom habitats existed in the survey area.

(2) Ground-truthing operations confirmed sidescan sonar interpretation of seafloor morphologies of interest,

(3) No hardbottom was found during ground-truthing operations.

(4) An analysis of historic beach profiles along Bogue Banks (Moffat and Nichol, 2008) does not suggest any rock outcrops along beach profiles.

Additional side-scan sonar surveys within the proposed Shackleford Banks nearshore placement area and the proposed expanded Nearshore West revealed no evidence of hardbottoms. (USACE 2010a).

4.5.7 Essential Fish Habitat

Table 4-5 shows the categories of EFH and Habitat Areas of Particular Concern (HAPC) for managed species, which were identified in the Fishery Management Plan Amendments affecting the South Atlantic area pursuant to implementing the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA). Table 4-6 lists the federally managed fish species of North Carolina for which Fishery Management Plans have been developed by the South Atlantic Fishery Management Council (SAFMC), Mid-Atlantic Fishery Management Council (MAFMC), and National Marine Fisheries Service (NMFS). In addition, Table 4-6 shows EFH by fish life stage and ecosystem type for those species that have designated EFH. The fish species and habitats shown in these tables require special consideration to promote their viability and sustainability.

ESSENTIAL FISH HABITAT	GEOGRAPHICALLY DEFINED HABITAT AREAS OF PARTICULAR CONCERN
Estuarine Areas	**Area - Wide**
Estuarine Emergent Wetlands	Council-designated Artificial Reef Special Management Zones
Estuarine Scrub / Shrub Mangroves	Hermatypic (reef-forming) Coral Habitat & Reefs
Submerged Aquatic Vegetation (SAV)	Hard Bottoms
Oyster Reefs & Shell Banks	Hoyt Hills
Intertidal Flats	*Sargassum* Habitat
Palustrine Emergent & Forested Wetlands	State-designated Areas of Importance of Managed Species
Aquatic Beds	Submerged Aquatic Vegetation
	Coastal Inlets
Estuarine Water Column[2]	
Seagrass	
Creeks	
Mud Bottom	
Marine Areas	**North Carolina**
Live / Hard Bottoms	Big Rock
Coral & Coral Reefs	Bogue Sound
Artificial / Manmade Reefs	Pamlico Sound at Hatteras / Ocracoke Islands
Sargassum	Capes Fear, Lookout, & Hatteras (sandy shoals)
Water Column[2]	New River
	The Ten Fathom Ledge
	The Point

[1]Essential Fish Habitat areas are identified in Fishery Management Plan Amendments for the South Atlantic and Mid-Atlantic Fishery Management Councils. Geographically Defined Habitat Areas of Particular Concern are identified in Fishery Management Plan Amendments affecting the South Atlantic Area. Information in this table was derived from <u>Essential Fish Habitat: A Marine Fish Habitat Conservation Mandate for Federal Agencies</u>. February 1999 (Revised 10/2001) (Appendices 4 and 5).

[2]EFH for species managed under NMFS Billfish and Highly Migratory Species generally falls within the marine and estuarine water column habitats designated by the Fishery Management Councils.

Table 4-5. Categories of EFH and HAPCs Identified in Fishery Management Plan Amendments Affecting the South Atlantic Area [1,2]

E-EGGS L-LARVAL J-JUVENILE A-ADULT N/A-NOT FOUND	Beaufort Inlet	Bogue Sound	Bogue Inlet	Atlantic Ocean South of Cape Hatteras
COASTAL DEMERSALS				
Red Drum	E L J A	E L J A	E L J A	JA
Bluefish	J A	J A	J A	ELJA
Summer Flounder	L J A	L J A	L J A	ELJA
INVERTEBRATES				
Brown Shrimp	E L J A	L J A	E L J A	ELJA
Pink Shrimp	E L J A	L J A	E L J A	ELJA
White Shrimp	E L J A	L J A	E L J A	ELJA
Calico Scallop	N/A	N/A	N/A	ELJA
COASTAL PELAGICS				
Dolphinfish	J A	N/A	J A	ELJA
Cobia	L J A	J A	L J A	ELJA
King Mackerel	J A	J A	J A	ELJA
Spanish Mackerel	L J A	L J A	L J A	ELJA
HIGHLY MIGRATORY				
Bigeye Tuna	N/A	N/A	N/A	ELJA
Bluefin Tuna	N/A	N/A	N/A	JA
Skipjack Tuna	N/A	N/A	N/A	JA
Yellowfin Tuna	N/A	N/A	N/A	ELJA
Swordfish	N/A	N/A	N/A	ELJA
Blue Marlin	N/A	N/A	N/A	ELJA
White Marlin	N/A	N/A	N/A	ELJA
Sailfish	N/A	N/A	N/A	ELJA
Little Tunny	N/A	N/A	N/A	ELJA
SHARKS				
Spiny Dogfish	J A	N/A	J A	JA
Smooth Dogfish	J A	J	J A	JA
Small Coastal Sharks	J A	J A	J A	JA
Large Coastal Sharks	J A	N/A	J A	JA
Pelagic Sharks	N/A	N/A	N/A	JA
Prohibited/Research Sharks	J A	N/A	J A	JA
SNAPPER/GROUPER				
Black Sea Bass	L J A	L J A	L J A	ELJA
Bank Sea Bass	N/A	N/A	N/A	ELJA
Rock Sea Bass	J	J	J	ELJA
Gag	J A	J	J A	ELJA
Graysby	N/A	N/A	N/A	ELJA

Table 4-6. EFH Species for Coastal North Carolina

E-EGGS L-LARVAL J-JUVENILE A-ADULT N/A-NOT FOUND	Beaufort Inlet	Bogue Sound	Bogue Inlet	Atlantic Ocean South of Cape Hatteras
Speckled Hind	N/A	N/A	N/A	ELJA
Yellowedge Grouper	N/A	N/A	N/A	ELJA
Coney	N/A	N/A	N/A	ELJA
Red Hind	N/A	N/A	N/A	ELJA
Goliath Grouper	N/A	N/A	N/A	ELJA
Red Grouper	N/A	N/A	N/A	ELJA
Misty Grouper	N/A	N/A	N/A	ELJA
Warsaw Grouper	N/A	N/A	N/A	ELJA
Snowy Grouper	N/A	N/A	N/A	ELJA
Yellowmouth Grouper	N/A	N/A	N/A	ELJA
Black Grouper	J	J	J	ELJA
Scamp	N/A	N/A	N/A	ELJA
Blackfin Snapper	N/A	N/A	N/A	ELJA
Red Snapper	N/A	N/A	N/A	ELJA
Cubera Snapper	N/A	N/A	N/A	ELJA
Lane Snapper	N/A	N/A	N/A	ELJA
Silk Snapper	N/A	N/A	N/A	ELJA
Vermillion Snapper	N/A	N/A	N/A	ELJA
Mutton Snapper	N/A	N/A	N/A	ELJA
Gray Snapper	J	J	J	ELJA
Gray Triggerfish	N/A	N/A	N/A	ELJA
Yellow Jack	J	J	J	ELJA
Blue Runner	J	J	J	ELJA
Crevalle Jack	J	J	J	ELJA
Bar Jack	J	J	J	ELJA
Greater Amberjack	N/A	N/A	N/A	ELJA
Almaco Jack	N/A	N/A	N/A	ELJA
Banded Rudderfish	N/A	N/A	N/A	ELJA
Atlantic Spadefish	N/A	N/A	N/A	ELJA
White Grunt	N/A	N/A	N/A	ELJA
Tomtate	N/A	N/A	N/A	ELJA
Hogfish	N/A	N/A	N/A	ELJA
Puddingwife	N/A	N/A	N/A	ELJA
Sheepshead	J A	J A	J A	ELJA
Red Porgy	N/A	N/A	N/A	ELJA
Longspine Porgy	N/A	N/A	N/A	ELJA

Table 4-6 (continued). EFH Species for Coastal North Carolina

E-EGGS L-LARVAL J-JUVENILE A-ADULT N/A-NOT FOUND	Beaufort Inlet	Bogue Sound	Bogue Inlet	Atlantic Ocean South of Cape Hatteras
Scup	N/A	N/A	N/A	ELJA
Blueline Tilefish	N/A	N/A	N/A	ELJA
Sand Tilefish	N/A	N/A	N/A	ELJA
SMALL COASTAL SHARKS			PROHIBITED SHARKS	
Atlantic Sharpnose Shark				Sand Tiger
Finetooth Shark				Bigeye Sand Tiger
Blacknose Shark				Whale Shark
Bonnethead				Basking Shark
LARGE COASTAL SHARKS				White Shark
Silky Shark				Dusky Shark
Tiger Shark				Bignose Shark
Blacktip Shark				Galapagos Shark
Spinner Shark				Night Shark
Bull Shark				Reef Shark
Lemon Shark				Narrowtooth Shark
Nurse Shark				Shark
Scalloped hammerhead				Smalltail Shark
Great Hammerhead				Atlantic Angel Shark
Smooth Hammerhead				Longfin mako
				Bigeye Thresher
PELAGIC SHARKS				Sharpnose Sevengill shark
Shortfin Mako				Bluntnose sixgill Shark
Porbeagle				Bigeye Sixgill Shark
Thresher Shark				
Oceanic Whitetip Shark				
Blue Shark			RESEARCH SHARKS	
				Sandbar Shark

Table 4-6 (continued). EFH Species for Coastal North Carolina

The State of North Carolina defines Primary Nursery Areas (PNAs) as tidal salt waters that provide essential habitat for the early development of commercially important fish and shellfish. It is in these estuarine areas that many fish species undergo initial post-larval development. The North Carolina Marine Fisheries Commission designates PNAs. Neither Morehead City Harbor nor the beaches of Bogue Banks or Shackleford Banks are located within a designated Primary Nursery Area (PNA) (15 NC Administrative Code 3B .1405).

The State of North Carolina, Department of Environmental Quality, Division of Marine Fisheries Artificial Reef Program manages six reefs that are located off Bogue Banks (Figure 4-9). They are Artificial Reefs (AR) 315, AR 320, AR 330, AR 340, AR 342, and AR 345. None are in proximity to the proposed work.

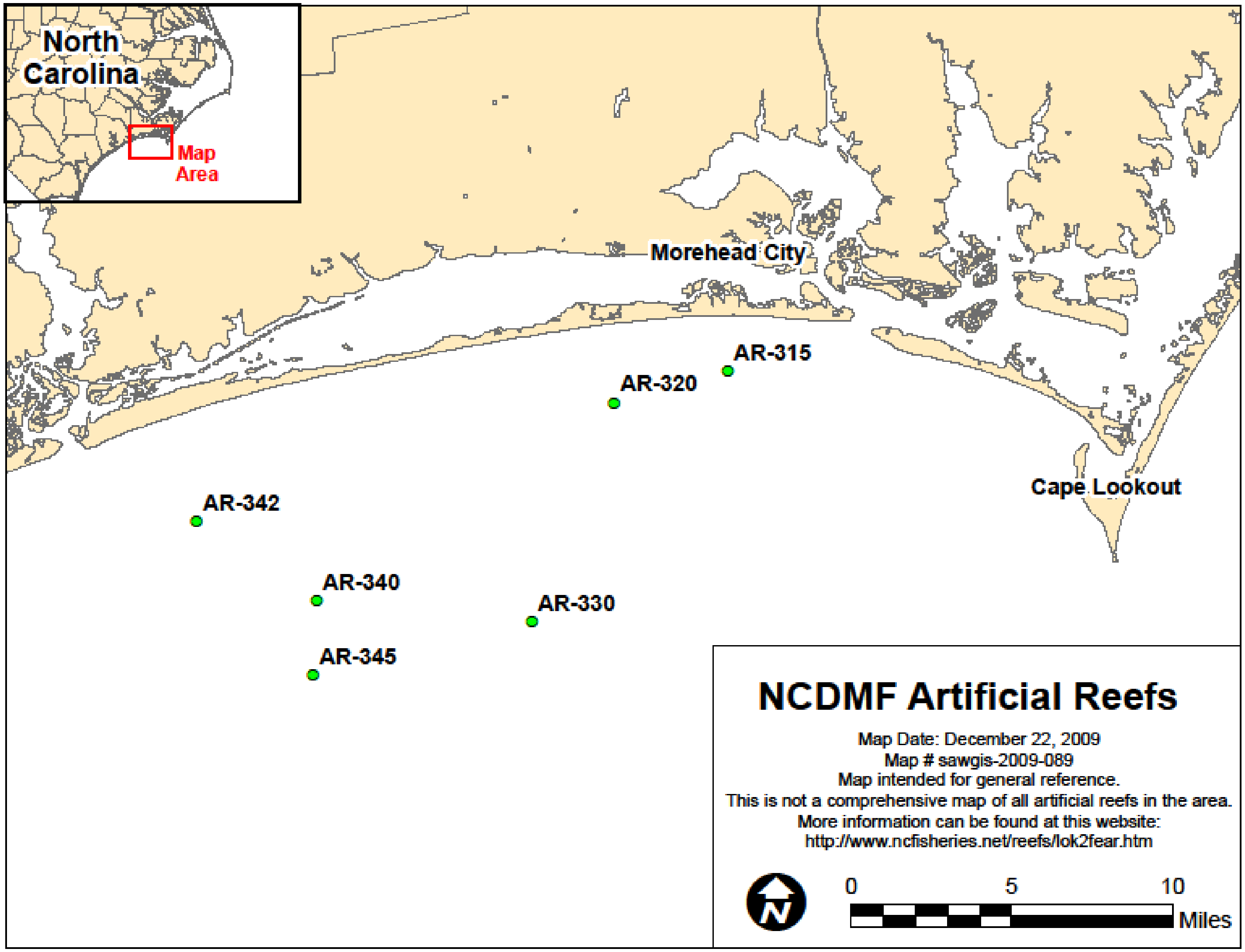


Figure 4-9. Location of NCDMF Artificial Reefs in the Project Area

4.6 Wetlands and Floodplains

Coastal wetlands of the project vicinity include tidal salt marshes, which occur along the shorelines and island fringes along the backside of Bogue and Shackleford Banks. Intertidal wetlands of the area are very important ecologically because of their high primary productivity, their role as nursery areas for larvae and juveniles of many marine species, and their refuge/forage value to wildlife. In addition, they provide aesthetically valuable natural areas. Many types of wetland communities are present in the project area including smooth cordgrass marsh, needlerush marsh, saltmeadows, and high marsh. All are important primary producers of organic matter and, therefore, serve as part of the base of the aquatic food chain. Smooth cordgrass (*Spartina alterniflora*) marshes occur within the intertidal zone along the sounds and tidal creeks and provide valuable nursery habitat for many commercially valuable species of marine and estuarine organisms. The frequent removal of organic material and the daily tidal sedimentation processes make salt marsh communities very productive (Schafale and Weakley 1990). Needlerush marsh is dominated by black needlerush (*Juncus romerianus*) and occurs in areas that are irregularly flooded. Saltmeadows are essentially pure stands of salt meadow cordgrass (*Spartina patens*), which can occur between 3.5–5.0 ft. above mean sea level. Salt grass (*Distichlis spicata*), sea lavender (*Limonium carolinianum*), glasswort (*Salicornia* spp.), and sea ox-eye (*Borrichia frutescens*) are also prominent plants in this community. High marsh is a transitional community between high ground areas and wetlands and, depending on location and frequency of flooding, may have characteristics of either. It is important in stabilizing the shifting sands of the barrier island. Given time and protection, it will eventually become vegetated with dominant shrub species such as marsh elder (*Iva frutescens*), wax myrtle (*Myrica cerifera*), and yaupon (*Ilex vomitoria*) (Wilson 1962).

Section 404 wetlands are those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support a prevalence of vegetation typically adapted for life in saturated soil conditions (33 C.F.R. § 328.3). Wetlands possess three essential characteristics: hydrophytic vegetation, hydric soils, and wetland hydrology. Along the beaches of Bogue Banks, the nearshore placement areas off Bogue and Shackleford Banks, and the ODMDS there are no jurisdictional Section 404 wetlands. There may be wetlands adjacent to the Brandt Island disposal area. Once Brandt Island reaches capacity, if a dike raise or expansion is determined to be feasible, an Environmental Assessment (EA) will be prepared and all appropriate environmental clearances will be obtained.

Floodplains. The 100-year flood plain is established by the Federal Emergency Management Agency (FEMA) and is identified on Federal Insurance Rate Maps. Base flood elevations for flood zones and velocity zones are also identified by FEMA, as are designated floodways. The beach placement areas within the project are within the 100-year floodplain. Beach placement of dredged material on either Bogue and/or Shackleford Banks could not be accomplished outside the floodplain.

4.7 Terrestrial Resources

The terrestrial resources of Brandt Island, Bogue Banks, and Shackleford Banks include vegetation, wildlife, birds, and mammals and are described below.

4.7.1 Vegetation

When compared to most of North Carolina's upland communities, the beach and dune community in the project area could be considered depauperate in both plants and animals. The environment on the beach is severe because of constant exposure to salt spray, shifting sands, wind, and sterile soils with low water retention capacity. Beach vegetation known from the area includes beach spurge (*Euphorbia polygonifolia*), sea rocket (*Cakile edentula*) and pennywort (*Hydrocotyle bonariensis*). The threatened plant, seabeach amaranth (*Amaranthus pumilis*) occurs sporadically along the dune faces of Bogue Banks and Shackleford Banks. The dunes along Bogue and Shackleford Banks are more heavily vegetated with American beach grass (*Ammophila breviligulata*), panic grass (*Panicum amarum*) sea oats (*Uniola paniculata*), broom straw (*Andropogon virginicus*) and salt meadow hay (*Spartina patens*) being commonly observed.

The low amount of vegetation found on the suburban and developed Bogue Banks is primarily due to human presence. In comparison, the relatively low human presence on Shackleford Banks results in a more heavily vegetated shoreline.

The east-to-west aligned Shackleford Banks extends from Beaufort Inlet on the west to Barden's Inlet on the east (Figure 4-8). Back Sound and the Atlantic Ocean border Shackleford Banks along the northern and southern boundaries. The upland portion of the barrier island is approximately 2,280 acres (Au 1974). The elevation of the dunes are higher in the western portion of the barrier island near Beaufort Inlet and lower in elevation in the eastern portion near Barden's Inlet. According to an early 1853 U.S. Coast and Geodetic Survey map, the barrier island was completely covered by forest (Au 1974). Because of anthropogenic influences such as stock grazing (goats, cattle, horses, and sheep), cutting trees for homes and boat building, as well as the hurricane of August 1899, the forested areas were either removed or killed (Au 1974). Once the vegetation was removed, successive storms have caused the loose sand to cover the remaining forested areas. According to Au (1974), only 5% of the island is covered by forest. The remaining maritime forest is predominantly vegetated with live oak (*Quercus virginiana*) and red cedar (*Juniperus virginiana*).

Vegetation at Cape Lookout National Seashore forms distinctive ecological zones across the barrier islands as shown in the Figure 4-10, Cross Section of Barrier Island Ecological Zones, below. The zones and some of their dominant plants, according to Snow and Godfrey (1978), which was adapted from Au (1974) are:

Beaches--essentially devoid of vegetation except unicellular algae.

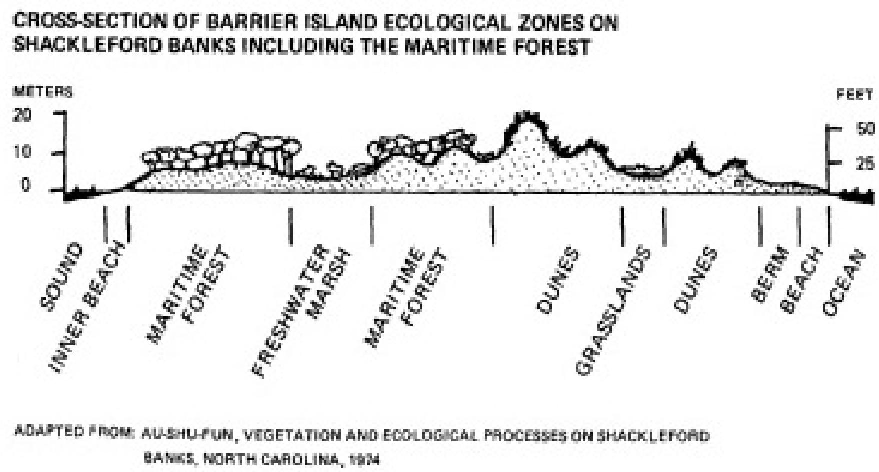


Figure 4-10. Cross Section of Barrier Island Eco-Zones on Shackleford Banks

Berms--created by a few plants such as sea oats growing in the driftline, which may build small dunes, depending on storm frequency.

Tidal Flats--intertidal areas essentially unvegetated except for stands of salt marsh cordgrass; found at inlets.

Dunes--low scattered dunes formed by sea oats in overwash-influenced areas, and high densely vegetated dune fields where vines such as Virginia creeper (*Parthenocissus quinquefolia*) may be found on the back side.

Open Grasslands--sparsely vegetated by salt meadow cordgrass and pennywort, both of which grow up through sand after burial in overwash.

Closed Grasslands--greater cover of pennywort, broom sedge, and hairgrass(*Elocharis acicularis*); Also species of rush (*Elocharis spp.*) where water stands. salt meadow cordgrass, closer to the water table.

Woodlands--shrub thickets of wax myrtle (*Myrica cerifera*), silverling (*Baccharis glomeruliflora*), or of yaupon (*Ilex vomitoria*) and live oak; maritime Virginia red cedar, and American holly (*Ilex opaca*). Both protected lands, marsh elder (*Iva frutescens*), and forests of live oak, are on higher ground.

High Salt Marshes--dominated by black needlerush (*Juncus roemerianus*) and salt meadow cordgrass *(Spartina Patens)*; flooded by spring and storm tides.

Low Salt Marshes--dominated by salt marsh cordgrass *i* flooded at mean high tide .

Subtidal Marine Vegetation--extensive stands of eelgrass (*Zostera spp*.) and widgeon grass (*Ruppia maritima*) in protected, shallow waters.

Because the Shackleford Banks faces the prevailing winds, sand is blown into the dunes, increasing their height and protecting the maritime forest at the western end. Expanses of salt marsh are found to the east of the maritime forest on Shackleford .

From 1943 to 1976, the ocean shoreline of Shackleford Banks eroded approximately 49 feet; an average of 1.5 feet per year (Dolan and Heywood, 1977). Figure 4-11 shows the 1974 vegetation line superimposed on September 2010 aerial photography. It appears that over 36 years (from 1974 to 2010), Shackleford Banks has experienced significant erosion along its shoreline. In some sections of the ocean beach, up to 150 meters (about 500 feet) have been eroded, which translates to an average erosion rate of about 14 feet per year.

Figure 4-11. Shackleford Banks 1974 GIS Vegetation Line (green) Superimposed on 2010 Aerial Photograph

4.7.2 Wildlife

Both Bogue Banks and Shackleford Banks have similar wildlife species and populations residing in the project area. The relatively low human presence on Shackleford Banks results in a greater wildlife population than the suburban and developed Bogue Banks. The main exception is the wild horses that are unique to Shackleford Banks.

Mammals. Gray squirrels (*Sciurus carolinensis*) and marsh rabbits (*Sylvilagus palustris*) are abundant on both Bogue and Shackleford Banks. White-tailed deer (*Odocoileus virginianus*) are present, though not in high density. Furbearers that have been observed include raccoon (*Procyon lotor*), mink (*Neovison vison*), muskrat (*Ondatra zibethicus*), otter (*Lontra canadensis*), fox (*Vulpes vulpes*), nutria (*Myocaster coypus*), and opossum (*Didelphis virginiana*). A total of about 32 mammal species are believed to be present on Bogue Banks, Shackleford Banks and Cape Lookout. This list contains 14 species that are primarily carnivorous and 18 rodent species (NPS 1983).

In the herbaceous dune areas on both Bogue and Shackleford Banks, mammals occurring here are opossums, cottontails, raccoons, feral house cats, shrews (*Sorex araneus*), moles (*Talpidae spp.*), voles (*Microtus pennsylvanicus*), and house mice (*Mus musculus*). Shackleford Banks is home to over 100 horses with the population is generally managed between 110 and 130 horses. The National Park Service and the Foundation for Shackleford Horses, Inc. cooperatively manage the horses, pursuant to the legislation and a Memorandum of Understanding updated in 2007.

Reptiles and Amphibians. A total of 93 amphibian and reptile species are believed to be present on both Bogue and Shackleford Banks (NPS 1983). Species observed include southern leopard frog (*Lithobates sphenocephalus*), green tree frog (*Hyla cinerea*), black rat snake (*Pantherophis obsoletus*), eastern cottonmouth (*Agkistrodon piscivorus*), yellow-bellied turtle (*Trachemys scripta scripta*), and snapping turtle (*Chelydra serpentina*). On Bogue and Shackleford Banks the list of species includes 42 amphibian and 51 reptile species. The largest group of amphibians is frogs, which include 18 species, followed by salamander/newts, 14 species; toads, 6 species; and other amphibians, 4 species. The largest group of reptiles is snakes, 31 species, followed by turtles, 11 species; and lizards/skinks, 9 species (NPS 1983).

Birds. The inlet shorelines on both Bogue Banks (including Brandt Island) and Shackleford Banks have consistently supported bird-nesting habitat. American oystercatchers(*Haematopus palliatus*), least terns (*Sterna antillarum*), and Wilson's plovers (*Charadrius wilsonia*) are nesting on bare sandy flats adjacent to the inlet (Personal Communication, 26 November 2008, Sue Cameron, NC Wildlife Resources Commission). Historically, piping plovers (*Charadrius melodus*), common terns (*Sterna hirundo*), willet (*Catoptrophorus semipalmatus*), also have nested in these areas. During Migratory periods, piping plover, Wilson's plover, semipalmated plover (*Charadrius semipalmatus*), red knot (*Calidris canutus*), sandwich tern (*Sterna sandvicensis*, Forster's tern (*Sterna forsteri*), Royal tern (*Sterna maxima*), least tern (*Sternula antillarum*), gull-billed tern (*Sterna nilotica*), common tern (*Sterna hirundo*), black tern (*Chlidonias niger*), Caspian tern (*Sterna caspia*), herons, egrets, marbled godwit (*Limosa fedoa*), laughing gull (*Larus atricilla*) and cormorant (*Phalacrocorax auritus*) are commonly found in and around the inlets. Overwintering bird species include piping plover, brown pelican, cormorants, Foster's tern, Royal tern, dunlin (*Calidris alpine)*, and various gull species (Fussell 1985).

In the herbaceous dune areas, marsh hawks (*Falco cyaneus*), kestrels (*Falco sparverius*), and other birds of prey forage. Other birds occurring in this area are mourning doves (*Zenaida macroura*), tree swallows (*Tachycineta bicolor*), fish crows (*Corvus ossifragus*), starlings (*Sturnus vulgaris*), meadowlarks (*Sturnella magna*), red-winged blackbirds (*Agelaius phoeniceus*), boat tailed grackles (*Quiscalus major*), and savannah sparrows (*Passerculus sandwichensis*) (NPS 1983).

Colonially nesting waterbirds (gulls, terns, and wading birds) are an important part of the project area ecosystem and add a vital element to the overall aesthetic appeal of the area for the many tourists that visit it each year. These species formerly nested primarily on the barrier islands of the region but have had most of these nesting sites usurped by development or recreational activities. With the loss of their traditional nesting areas, these species have retreated to the relatively undisturbed dredged material disposal islands, which border the navigation channels in the area. These islands often offer ideal nesting areas as they are close to food sources, well removed from human activities, and are isolated from mammalian egg and nestling predators (USFWS 2002).

Species of colonial waterbirds which have been documented to nest on the disposal islands in Bogue Sound or inlets of the project area are shown on Table 4-7. Data was taken from the U.S. Fish and Wildlife Service (USFWS) Draft Coordination Act Report, Bogue Banks Shore Protection Study (USFWS 2002). Other species also use the islands for loafing or roosting during migratory periods or the winter months.

Migratory shorebirds may also use the project area for foraging and roosting habitat (Personal Communication, 26 November 2008, Sue Cameron, NC Wildlife Resources Commission).

The inlet spits, sand flats, and point of Cape Lookout National Seashore also provide nesting habitat for several species of Colonial Waterbirds (CWB). The least tern (*Sterna antillarum*), common tern (*Sterna hirundo*), gull-billed tern (*Sterna nilotica*), and black skimmer (*Rynchops niger*) nest here in single species and mixed species colonies. According to the Cape Lookout National Seashore Colonial Waterbird 2009 Summary**,** only one small colony on Shackleford Banks had 4 black skimmer nests and 4 Forester tern nests, but these nests were lost to raccoon predation. The small CWB colony on Shackleford Banks is located near Barden's Inlet.

Colonial Waterbirds
least tern (*Sterna antillarum*)
Forster's tern (*Sterna forsteri*)
common tern (*Sterna hirundo*)
gull-billed tern (*Gelochelidon nilotica*)
black skimmer (*Rynchops niger*)
glossy ibis (*Plegadis falcinellus*)
white ibis (*Eudocimus albus*)
great egret (*Casmerodius albus*)
snowy egret (*Egretta thula*)
cattle egret (*Bubulcus ibis*)
tricolored heron (*Hydranassa tricolor*)
green heron (*Butorides striatus*)
little blue heron (*Egretta caerulea*)
black-crowned night-heron (*Nycticorax nycticorax*)
great blue heron (*Plegadis falcinellus*)

Table 4-7. Colonial Waterbirds Documented to Nest in Project Vicinity (David Allen, NC Wildlife Resources Commission 2010)

4.8 Threatened and Endangered Species (includes State Protected Species)

The Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531–1543), provides a program for the conservation of threatened and endangered (T&E) plants and animals and the habitats in which they are found. In accordance with section 7 (a)(2) of the ESA, the USACE has been in consultation with the USFWS and NMFS since beginning this study to ensure that effects of the proposed project would not jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat of such species.

Updated lists of threatened and endangered (T&E) species for the project area were obtained from NMFS (Southeast Regional Office, St. Petersburg, FL) and the USFWS (Field Office, Raleigh, NC). These were combined to develop the composite list shown in Table 4-8, which includes T&E species that could be present in the area based upon their historical occurrence or potential geographic range. However, the actual occurrence of a species in the area depends upon the availability of suitable habitat, the season of the year relative to a species' temperature tolerance, migratory habits, and other factors.

Additionally, Table 4-9 provides a list of all State Protected Species that may occur in the project area. Mr. John Finnegan, Information Systems Manager, North Carolina Natural Heritage Program, Office of Conservation, Planning and Community Affairs, NC Department of Environment and natural Resources provided these listed species found in Table 4-9.

Species Common Names	Scientific Name	Federal Status
Vertebrates		
American alligator	*Alligator mississippiensis*	T(S/A)
Eastern cougar	*Felis concolor couguar*	Endangered*****
North Atlantic Right whale	*Eubaleana glacialis*	Endangered
Blue Whale	*Balaenoptera musculus*	Endangered
Sei whale	*Balaenoptera borealis*	Endangered
Sperm whale	*Physeter macrocephalus*	Endangered
Finback whale	*Balaenoptera physalus*	Endangered
Humpback whale	*Megaptera novaeangliae*	Endangered
Green sea turtle	*Chelonia mydas*	Threatened[1]
Hawksbill turtle	*Eretmochelys imbricata*	Endangered
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Loggerhead sea turtle	*Caretta caretta*	Threatened
West Indian Manatee	*Trichechus manatus*	Endangered
Piping Plover	*Charadrius melodus*	Threatened
Red-cockaded woodpecker	*Picoides borealis*	Endangered
Roseate tern	*Sterna dougallii*	Endangered
Red knot	*Calidris canutus rufa*	Proposed Threatened
Smalltooth sawfish	Pristis pectinata	Endangered
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered
Atlantic Sturgeon	*Acipenser oxyrhynchus oxyrhynchus*	Endangered
Invertebrates		
a skipper (butterfly)	*Atrytonopsis sp1*	FSC
Vascular Plants		
Rough-leaved loosestrife	*Lysimachia asperulaefolia*	Endangered
Seabeach amaranth	*Amaranthus pumilus*	Threatened

[1]Green turtles are listed as threatened, except for breeding populations in Florida and on the Pacific Coast of Mexico, which are listed as endangered.

KEY:

Status Definition

Endangered - A taxon "in danger of extinction throughout all or a significant portion of its range."

Threatened - A taxon "likely to become endangered within the foreseeable future throughout all or a significant portion of its range."

FSC – Federal Species of Concern. A species under consideration for listing, for which there is insufficient information to support listing at this time.

T(S/A) - Threatened due to similarity of appearance (e.g., American alligator)--a species that is threatened due to similarity of appearance with other rare species and is listed for its protection. These species are not biologically endangered or threatened and are not subject to Section 7 consultation.

Species with 1 asterisk behind them indicate historic record: * Historic record - the species was last observed in the county more than 50 years ago.

Table 4-8. Threatened and Endangered Species Potentially Present In Carteret County, North Carolina

Name Category	Scientific Name	Common Name	State Status
Vascular Plant	*Amaranthus pumilus*	Seabeach Amaranth	T
	Calopogon multiflorus	Many-flower Grass-pink	E
	Dichanthelium caerulescens	Blue Witch Grass	E
	Lysimachia asperulifolia	Rough-leaf Loosestrife	E
	Myriophyllum laxum	Loose Water-milfoil	T
	Platanthera integra	Yellow Fringeless Orchid	T
	Pyxidanthera brevifolia	Sandhills Pixie-moss	E
	Rhynchospora macra	Southern White Beaksedge	E
	Rhynchospora odorata	Fragrant Beaksedge	E
	Rhynchospora pleiantha	Coastal Beaksedge	T
	Solidago verna	Spring-flowering Goldenrod	T
	Spiranthes longilabris	Giant Spiral Orchid	T
	Stylisma pickeringii var.pickeringii	Pickering's Dawn flower	E
	Utricularia olivacea	Dwarf Bladderwort	T
Vertebrate Animal	*Acipenser brevirostrum*	Shortnose Sturgeon	E
	Alligator mississippiensis	American Alligator	T
	Ammodramus henslowii susurrans	Eastern Henslow's Sparrow	SC
	Caretta caretta	Loggerhead Sea turtle	T
	Charadrius melodus	Piping Plover	T
	Charadrius wilsonia	Wilson's Plover	SC
	Chelonia mydas	Green Sea turtle	T
	Crotalus adamanteus	Eastern Diamondback Rattlesnake	E
	Crotalus horridus	Timber Rattlesnake	SC
	Dermochelys coriacea	Leatherback Sea turtle	E
	Egretta caerulea	Little Blue Heron	SC
	Egretta thula	Snowy Egret	SC
	Egretta tricolor	Tricolored Heron	SC
	Eretmochelys imbricata	Hawksbill Sea turtle	E
	Falco peregrinus	Peregrine Falcon	E
	Gelochelidon nilotica	Gull-billed Tern	T
	Haematopus palliatus	American Oystercatcher	SC
	Haliaeetus leucocephalus	Bald Eagle	T
Vertebrate Animal	*Heterodon simus*	Southern Hognose Snake	SC
	Ixobrychus exilis	Least Bittern	SC
	Lampropeltis getula sticticeps	Outer Banks Kingsnake	SC
	Laterallus jamaicensis	Black Rail	SC
	Lepidochelys kempii	Kemp's Ridley Sea turtle	E

NC Status – Endangered (E); Threatened (T); Special Concern (SC); E, T, and SC status species are given legal protection status by the NC Wildlife Resources Commission.

Table 4-9. List of State Protected Species Potentially Present in Carteret County (NC Natural Heritage Program 2011)

Name Category	**Scientific Name**	**Common Name**	**State Status**
Vertebrate Animal	*Nerodia sipedon williamengelsi*	Carolina Watersnake	SC
	Malaclemys terrapin centrata	Carolina Diamondback Terrapin	SC
	Neotoma floridana floridana	Eastern Woodrat-Coastal Plain population	T
	Ophisaurus mimicus	Mimic Glass Lizard	SC
	Passerina ciris ciris	Eastern Painted Bunting	SC
	Peucaea aestivalis	Bachman's Sparrow	SC
	Picoides borealis	Red-cockaded Woodpecker	E
	Plegadis falcinellus	Glossy Ibis	SC
	Puma concolor couguar	Eastern Cougar	E
	Rana capito	Carolina Gopher Frog	T
	Rynchops niger	Black Skimmer	SC
	Sistrurus miliarius	Pigmy Rattlesnake	SC
	Sterna dougallii	Roseate Tern	E
	Sterna hirundo	Common Tern	SC
	Sternula antillarum	Least Tern	SC
	Trichechus manatus	West Indian Manatee	E

NC Status – Endangered (E); Threatened (T); Special Concern (SC); E, T, and SC status species are given legal protection status by the NC Wildlife Resources Commission.

Table 4-9 (continued). List of State Protected Species Potentially Present in Carteret County (NC Natural Heritage Program 2011)

4.9 Cultural Resources

The following section describes the historical setting of the Beaufort and Morehead City project area; cultural, historic and archaeological resources in the Cape Lookout National Seashore (CALO), and the establishment of the CALO:

Archaeologists generally accept the earliest known human settlement of present-day North Carolina occurred sometime during the Paleo-Indian period (12,000 – 10,000 B.P.); though there is increasing evidence for earlier settlement. Paleo-Indians are presumed to have lived in mobile groups emphasizing hunting of large, migratory game.

Evidence of Paleo-Indians in the Coastal Plain is mostly limited to a small number of surface finds of fluted projectile points (Ward and Davis 1999). While the dearth of evidence suggests the region was sparsely populated, late Pleistocene and early Holocene sea levels were lower than today, and many Paleo-Indian sites are likely miles offshore from the present-day coastline (Lewis 2000; Phelps 1983). Warming trends melted glaciers and produced a rise in sea level to within a few meters of present levels by 9,000 B.P. and reached present sea level ca. 2,000 to 5,000 B.P. (Anderson et al. 1996; Lewis 2000).

The archaeological record of the Archaic period (10,000 – 3,000 B.P.) reflects new technologies and lifestyles as Archaic peoples adapted to climatic and environmental changes and mega-fauna extinctions that occurred during the Paleo-Indian period. Adaptive strategies to the changing environment focused on plant gathering and the hunting of modern game animals. Their tool kit included a variety of triangular, corner-notched, bifurcated, and stemmed projectile points, ground stone tools, adzes, drills, and gravers. Archaic social organization likely continued to center on extended families and bands with possible larger seasonal gatherings.

The Archaic period was an extremely important foundation upon which later, more complex societies would grow during the Woodland period (3,000 B.P. – A.D. 1650). The early Woodland period peoples, in particular, probably inhabited the same riverside locations and followed much the same lifestyle as their Archaic period predecessors. Coastal Archaic and Early Woodland period sites and artifact finds appear to be scattered, and significant occupations tend to occur during Middle and Late Woodland periods (Ward and Davis 1999). An increasing reliance on horticulture, semisedentary villages, and pottery-making became more widespread during the Early Woodland period (Ward and Davis 1999).

Regional cultures begin to appear in the Late Woodland period as agriculture, large population increase, and more permanent settlements occurred. The project area lies close to the border archaeologists have defined for separating the North Carolina Coastal Plain into north and south cultures based upon ethnohistoric records and linguistic and cultural attributes. The Tidewater zone from present-day Onslow County to Virginia was occupied by Algonkian-speaking tribes, while Siouanspeaking tribes resided south of this area to South Carolina (Phelps 1983; Ward and Davis 1999).

The Colington phase defines the cultural tradition of the Algonkian-speaking tribes in the Late Woodland to European contact. Shell-tempered pottery, ranked societies or chiefdoms, longhouse structures, and mass graves or ossuaries are defining traits of the Colington phase (Phelps 1983; Ward and Davis 1999). The Colington phase ended ca 1650 with the expansion of European colonial settlement from Virginia (Phelps 1983).

Historical Maritime Overview of Beaufort and Morehead City Vicinity. Among the earliest residents of Shackleford Banks and Cape Lookout during the late 1600s and early 1700s were whalers, who established a series of temporary camps and shelters amid the dunes. By the 1720s, Cape Lookout and Shackleford Banks became a more permanent base of operations for New England whalers (Angley 1982). When Beaufort was appointed as "a port for the unloading and discharging [of] vessels," in 1722 it was clear that successful development would also depend on trade entering and clearing through Beaufort Inlet (Paul 1970; Angley 1982). Unlike many of the inlets along the North Carolina coast, Beaufort Inlet was relatively stable and open and offered a safe and deep channel for ship traffic (Stick 1958).

Although Beaufort remained a relatively unimportant port during the eighteenth century, it did play a small role in Revolutionary War maritime activity. While the blockade imposed upon the American coast by the British Navy seriously impacted trade for many Colonial ports, shipping through Beaufort provided a portion of the supplies needed by the Patriots in North Carolina. In the years that followed the Revolution, North Carolina experienced an increase in the volume of maritime trade and shipbuilding. Just after the turn of the century, Beaufort Inlet was described as one of the best on the North Carolina coast, with "the channel being generally 3 1/4 to 3 1/2 fathoms" deep. Beaufort was mentioned as having a fairly vigorous, though small, shipbuilding industry (Tatham 1806). In 1810, Jacob Henry, a former representative from Carteret County to the North Carolina House of Commons, commented upon the local shipbuilding industry at Beaufort:

> The principal trade carried on here is ship building in which they have acquired a very considerable reputation.... Live oak and Cedar are the timbers principally used but the stock is by no means so abundant as it has been. Some of the swiftest sailors and best built Vessels in the United States have been launch'd here, particularly the Ship Minerva, a well-known Packet between Charleston and New York. There are at present five Vessels at the Stocks, two of which are ready to be launch'd (Newsome 1929).

The Beaufort vicinity was severely battered by a hurricane that struck the area in 1815. The storm later described as "being one of the most violent and disastrous ever known upon the coast" brought about significant changes to the ocean bar at Beaufort Inlet. The bar was "injured so that but 12 feet could be brought over it at low water." Fortunately the channel eventually recovered from the storm's damage and by 1830 depth on the bar had increased to eighteen feet at mean low water. By 1854 the bar channel had decreased slightly to a depth of 15½ feet and migrated slightly to the south (United States Congress, Senate Executive Document, No. 78, 33rd Congress, pp. 3-4).

Around 1841 John Motley Morehead, governor of North Carolina, had a vision of establishing a port facility at the eastern terminus of the Atlantic and North Carolina Railroad. A decision was finally reached in 1855 to locate the proposed port and rail facility on Sheppard's Point (Konkle 1922). The editor of the Greensboro *Patriot* described the conditions and natural advantages which he believed would benefit maritime traffic through Beaufort Inlet to the new port facility at Morehead City in September 1858:

> The inlet at Beaufort Harbor is, we understand, about three quarters of a mile wide, extending from the point on the Shackleford banks on the east to the point at Fort Macon on the west. Ships drawing from eighteen to twenty feet can cross the bar with safety. Ships crossing the bar, enter the Harbor near the Shackleford banks, then bear in a westwardly direction toward Fort Macon. From the bar at the inlet, across the Sound to Beaufort, is about three miles, this being about the widest part of the Harbor. The channel is in the form of a half-moon, one horn running eastwardly along the Shackleford banks, called Core Sound, and the other westwardly by Morehead and Carolina cities, which are situated on Bogue Sound. The deepest water is along Newport river, which runs in nearly a north direction between Morehead City and Beaufort, touching the railroad wharf in the former place. The main channel is about one mile wide, so that the inside of the channel would be some two miles from Beaufort, though vessels drawing from nine to ten feet water can approach the Beaufort wharves at full tide. Running up the channel about three miles from the bar, we come to the railroad wharf at Morehead City, where vessels drawing eighteen feet can approach with ease, and unload and take in lading with the greatest safety (Konkle 1922).

Within six months the rail and port facility at Morehead city was prospering, much to the chagrin of the people of Beaufort. Ships were continually calling at the wharfs and being loaded with cargoes directly from train cars:

> Here a steamer drawing twenty feet of water, and the locomotive weighing twenty or thirty tons, with its whole train, may be alongside each other; and this, too, on each side of the wharf at the same time, while in front other vessels may be loading or discharging cargoes (Konkle 1922).

The development of Morehead City was soon disrupted by the Civil War. On 22 March 1862 Union forces occupied Morehead City. Four days later Union troops crossed the Newport River and took control of Beaufort. Fort Macon also fell into Union forces under General Ambrose E. Burnside following a fierce one-day siege

(Stick 1958). Preceding the final assault on Fort Macon, a Union gunboat and one or two smaller vessels were positioned inside Beaufort Inlet, controlling the approaches and exits to Bogue and Core sounds. On 22 April 1862, several Union vessels anchored near Harker's Island to the east of Beaufort, including the steamer *Alice Price* that served as General Burnside's temporary headquarters. When the fall of Fort Macon was imminent, Confederate forces were forced to burn the bark *Glen* on 25 April to keep it out of Union hands. The following day, Colonel Moses J. White, commander of Fort Macon, surrendered to generals Parks and Burnside on Shackleford Banks (Angley 1982; Stick 1958).

The occupation of Fort Macon and the surrounding vicinity provided Union naval forces with access to a deep-water port and place of rendezvous that was used to support the blockading squadron throughout the remainder of the war. During December of 1864 and January of 1865 fleets under Admiral David Porter, massed at Beaufort Harbor in preparation for their assault on Fort Fisher in Wilmington, the last major stronghold of the Confederacy in North Carolina. During the Civil War at least five Confederate vessels were captured at sea in the Cape Lookout area: the schooners *Edwin, Julia, Revere,* and *Louisa Agnes,* captured in 1861; and the steamer *Banshee,* taken on 21 November 1863 (Angley 1982; Price 1948). One Confederate vessel was totally lost in the vicinity as a result of enemy action. On 9 July 1864 the side-wheel steamer *Pevensey* was chased ashore and blown up on Bogue Banks, approximately nine miles west of Beaufort Inlet (Hill 1975). Not all known shipwrecks near Beaufort were a result of enemy action. On 12 June 1863 while en route from the Delaware Capes to Charleston, the U.S.S. *Lavender* ran aground in heavy seas near Cape Lookout Shoals. The *Lavender* was a screw tug of 173 tons. On 20 July 1865 the 186-ton Union screw steamer *Quinnebaugh* went ashore on Beaufort bar in rough weather after her machinery failed. The *Quinnebaugh* was transporting Union troops, refugees, and civilians north at the time of her loss (Shomette 1973, Berman 1972; Lytle and Holdcamper 1975).

Six years after the Civil War, the Federal Government began measures to reduce the severity of maritime disasters along the coast by establishing the United States Lifesaving Service. In 1874, seven stations were established along the North Carolina coast. In 1875 a similar station was authorized by congress for Cape Lookout. It was not until ten years later that the station was finally built. Over the following years three other stations would be established on Core Banks, and a facility was also established near Fort Macon, just west of Beaufort Inlet (Angley 1982; Stick 1958).

Menhaden fishing became an important source of income for the Cape Lookout and Beaufort area in the years following the Civil War. From 1865 to 1873, the State's first menhaden processing plant was in operation on Harker's Island. By the turn of the century, several plants were in operation at Beaufort and at various points on Bogue and Core sounds (Hill 1975).

Growth of Beaufort and Morehead City as ports was slow during the late nineteenth and early twentieth centuries. In the 1880s, the Federal Government began work on the improvement of Beaufort Inlet in the hopes of increasing the amount of maritime trade to the port communities. The depth over the bar in the latter 19th century was just over fifteen feet, but was said that "the Harbor entrance was rapidly deteriorating; its width, measured from Fort Macon to Shackleford Point, having increased 500 feet between the years 1864 and 1880" (Stick 1958; Angley 1982). The deterioration of the inlet was steadily increasing, and during 1880 the width of the inlet had increased 900 feet farther. As a means to prevent further erosion, jetties were constructed from both shores into the inlet. Over the next five years, five jetties were constructed on Shackleford Point and another six on Fort Macon Point. By 1889 the deterioration of the inlet caused by the erosion had been brought under control (Angley 1982; Stick, 1958).

Between 1905 and 1907 the channel across Beaufort Inlet bar was dredged to a depth of twenty feet at mean low water. A twenty-foot channel, two hundred feet wide, was also provided inside the inlet to the wharves at Morehead City. A smaller channel, seven feet deep and 100 feet wide, was provided to the wharves along the Beaufort waterfront (Angley 1982). The Army Corps of Engineers submitted several reports between 1907 and 1914 that indicated that both Morehead City and Beaufort were growing centers of maritime trade. The majority of vessels utilizing the two ports were fishing boats and small, shallow-draft cargo vessels (Angley 1982). Beaufort Inlet was described in 1907 as being limited in importance:

The present commerce through the inlet is small, owing in a large measure to the hitherto shallow draft of not generally more than 12 feet at mean low water that could be carried across the bar.

> The present annual commerce of Beaufort, N. C., the principal place on the water adjacent to this Harbor, amounts to about 64,000 tons annually, valued at $3,500,000, of which only about one-fourth to one-fifth passes through the inlet (United States Congress, House Document No. 1454, p.3).

Statistics for 1912 reflect that twelve sailing vessels and thirty-five gasoline-powered vessels were registered at Morehead City, for a total of forty-seven vessels weighing 570 net tons. At the rival port of Beaufort for the same year, 175 sailing vessels, 240 gasoline powered vessels, and six barges were register, for a total of 421 vessels with net registered tonnage of 6,005 (Angley 1982; United States Congress, House Documents No.1022:4-11 and No. 1108:6-7). A number of vessels that voyaged along the coast became victims of maritime hazards. Between 1 July 1898 and 30 June 1908, eighty-two vessels were reported lost off the North Carolina coast (United States Congress, House Document No. 315, pp. 5-6).

Several of the shipwrecks had themselves become hazards to navigation along the coast. On 20 and 27 February 1891 notices were carried in the Wilmington *Weekly*

Star that the Federal Government was in the process of removing wrecks that had become obstacles to other vessels:

> Masters and owners of vessels engaged in the coastwise trade will be glad to know that the commanding Officer of the USS *Yantic* has been ordered to cruise along the coast from Sandy Hook to Charleston, S. C. and to destroy, as far as practicable, all abandoned wrecks which are dangerous to navigation. There are a number of these wrecks on the coast of North Carolina and Virginia.
>
> Off the North Carolina coast the *Yantic* will find the schooner *Dudley Farlin,* twenty-four miles northwest of Bodie Island Light; the schooner *Mollie* J. *Saunders,* seven miles southeast of the same light; the steamer *Glenrath,* south by west of Cape Lookout Light, four or five miles farther in shore, the steamer *Aberlady Bay,* and a sunken wreck eighteen miles east-northeast of Frying Pan Shoal Lightship (Wilmington *Weekly Star,* 20 and 27 February 1891).

In a 1897 Congressional report the hazards found at Cape Lookout to maritime traffic were summarized by the captain of the life-saving station at Cape Lookout:

> I ascertain that, since 1888, 19 schooners, 6 steamships, and 1 bark were disabled or ashore around Cape Lookout that would have been unharmed in all probability, if a safe harbor had been near. Two of these steamships and many of the schooners proved total losses. Unknown wrecks are occasionally discovered on or near the shoals. Nine large vessels have been anchored south of the beach at one time during northeasters. When the wind shifted they had to go to sea. Twenty-two schooners have been seen at one time laying to under the lee of Lookout Shoals during a northeast gale, and 57 vessels have been sighted passing by in one day. The locality is being frequented more and more as seafaring men learn the advantage of it. The great danger at present is being caught in the great bight with a southerly gale (United States Congress, House Document No. 25, p. 5).

To prevent vessels from wrecking near Cape Lookout a lighthouse had been in use, but mariners often complained that the light was difficult to see. To remedy this a lightship was put in place at Cape Lookout Shoals in 1904 and remained in operation until 1933 when it was removed (Holland 1968; Stick 1958). In addition to the lightship, a lens lantern was erected in 1900 on Cape Lookout Bight for a "large number of vessels that seek a lee under Cape Lookout" (Holland 1968).

During World War I Cape Lookout Bay served as a rendezvous and staging area for convoys bound for Europe, while Morehead City was occasionally used as a distribution point. From 1926 to 1938 the Federal Government made considerable improvements to the use of the Port of Morehead City by increasing the depth of the channel from Beaufort Inlet to thirty feet (Stick 1952). In 1923 the tug *Juno* had sunk in the Beaufort Inlet channel causing considerable difficulty for other vessels to pass. The *Juno* was eventually dynamited to clear the entrance. This earlier event may have been a contributing factor in recognizing the need for channel improvements *(The Evening Dispatch,* 23 July 1923; Berman 1972; *List of Iron and Steel Vessels of the United States, 1904).*

Hostilities in the Cape Lookout vicinity were much more evident during the events of World War ll. For example, on one night, 18 March 1942, German submarines sank three tankers in the Cape Lookout area: the *Papoose,* the W. E. *Hutton,* and the E. *M*. *Clark.* Five days later another tanker, the *Naeco* was sunk in the same vicinity (Stick 1952). As a result of the high number of vessel losses occurred during the early stages of the war, defensive measures were put into place. Coastal communities were systematically blacked out; a more efficient convoy system was devised; and additional planes and patrol vessels were put into service for the Cape Lookout area and North Carolina coast in general (Stick 1952).

In the early 1950s, improvements were once again undertaken at Morehead City. A project was nearly completed by the summer of 1954 to widen the thirty foot channel to 300 feet to the port facilities, construct a 600-foot turning basin, and dredge a twelve-foot channel in Bogue Sound along the city's commercial waterfront (Angley 1982). By 1954 the main shipping channel to Beaufort had also been dredged to a depth of twelve feet and a width of one hundred feet. The improvements could easily accommodate sports and commercial fishing vessels and pleasure craft, but was inadequate to handle large, deep-draft cargo vessels (Angley 1982). Since the mid-1950s regular maintenance dredging has been undertaken at the channels leading into the Morehead City and Beaufort Harbors. Today Morehead City continues as a major deep-water port with several large vessels arriving yearly. Beaufort, however, has long since been eclipsed by her port rival and has been relegated to be content with being a small historic tourist community and haven for small fishing and pleasure craft.

Cape Lookout National Seashore Cultural, Historic, and Archaeological Resources. The environment of Cape Lookout National Seashore has deterred people from extensively settling the area, although historically the islands have served as prominent landmarks for mariners and have been busy with maritime activities. Early European sailors knew both the dangerous shoals off Cape Lookout Point and the safe harbor of Lookout Bight. In later years, the Cape Lookout lighthouse warned of the hazards, and life-saving operations rescued seamen in trouble.

Fishing has always been the dominant vocation of the Outer Bankers. With increased maritime activity, Portsmouth Village became a transshipment point where cargo was unloaded and reloaded when ships passed through the shallow Ocracoke Inlet. Later, Diamond City was established on Shackleford Banks for whaling, but it was abandoned during a period of hurricanes in the late 19th century. Today, virtually nothing remains of Diamond City, but a number of structures survive in Portsmouth

Village. The village is a unique reminder of past cultural and economic life on the Outer Banks.

The state historic preservation officer of North Carolina and the Advisory Council on Historic Preservation has been consulted about the seashore's cultural resources. The lighthouse complex is listed under state significance in the National Register of Historic Places. In addition to the lighthouse, the 25-acre complex includes the keeper's quarters, coal and wood shed, summer kitchen, and fuel storage building. The lighthouse is owned by the U. S. Coast Guard and the other structures belong to the NPS. The existing lighthouse structure dates from 1859, and its diagonal black and white checker pattern dates from 1873. There had been an earlier tower dating from 1812. Portsmouth Village is also entered in the National Register as a 250-acre historic district of state significance. There are 25 structures that are typical of coastal Carolina architecture of the 1820-1930 period, at least 8 cemeteries, and 10 ruins and/or sites of former residences. Earlier periods of the village's history are represented poorly by historic structures or not at all.

CALO has 36 recorded archeological sites. These sites are difficult to monitor and protect due to the changing landscape of the barrier islands (NPS 2007). Shell middens were found on the islands in the past, but most have been washed away by storms (NPS 2007). None of the aboriginal sites currently known to exist within the national seashore were felt to be culturally and scientifically significant enough to justify their nomination to the National Historic Register (NPS 2007).

The majority of the sites exist on the soundside of Shackleford Banks, primarily in the salt marshes; some are located on small, marshy islands adjacent to Shackleford. Little evidence of these sites remains due to advanced stages of erosion and other environmental factors. The sites have become damaged from overwash or are submerged at high tide, and only erosion remnants remain. Severe erosion and movement of the land mass have almost obliterated several sites. Some of the sites are covered with thick vegetation, obscuring portions of the site from view. One site has been affected by past use of the area by sheep and goats, to the extent that “little evidence of the site remains intact, or not” (Ehrenhard 1976). According to park staff, looting and vandalism of cultural resources is not a substantial problem.

Establishment of the Seashore. The Seashore’s (CALO) enabling legislation was passed in 1966 through the joint efforts of North Carolina and the National Park Service (Public Law 89-366, 80 Stat. 33 (March 10, 1966), codified at 16 U.S.C Section 459 *et seq*.). This followed studies about protection of the Outer Banks from storm destruction. The state of North Carolina concluded that the expense of rehabilitating and developing the banks as a public seashore exceeded state resources, and that the project should be handled by the Federal Government. Similarly, concern about the increasing development of America's few remaining natural seashores had been voiced by the NPS in its Surveys of the Atlantic and Gulf Coasts report (1955).

The Secretary of the Interior declared the establishment of the Seashore once there was enough land to sufficiently administer it (Federal Register, September 10, 1976). The enabling legislation defined the Seashore to include the outer banks of Carteret County, North Carolina, between Ocracoke Inlet and Beaufort Inlet, plus adjoining marshlands and waters. An administrative site at east Harkers Island was authorized and depicted on the map referenced in the amending legislation (map 623-20,009 dated March 1974). The Seashore was to be administered for the general purposes of public outdoor recreation, including conservation of natural features contributing to public enjoyment (PL 89-366).

The 55-mile-long narrow strips of sand comprising Cape Lookout National Seashore are breached today by two inlets. The northeast/southwest-oriented Core Banks is divided by Ophelia Inlet (Personal Communication, August 9, 2012, Dr. Michael Rikard, Resource Management Specialist, Cape Lookout National Seashore) into a 21-mile strip north of the inlet and a 22-mile strip plus the 3-mile spit south of the inlet. Barden Inlet separates the southern end of Core Banks from Shackleford Banks, the latter a 9-mile long island with an east-west orientation. Numerous inlets have opened, migrated, and closed in the past, and others can be expected to do the same into the future.

4.10 Aesthetic and Recreational Resources (Including Soundscape)

The total environment of barrier islands, ocean, estuaries, and inlets attract many residents and visitors to the area to enjoy the total aesthetic experience created by the sights, sounds, winds and ocean sprays.

On Bogue Banks, two ocean piers (i.e., Oceana and Doubletree Hotel) are located in the project area and are considered important recreational facilities. During fall months, recreational surf fishing is a popular activity on both Bogue and Shackleford Banks. Fort Macon State Park and the North Carolina State Aquarium in Pine Knoll Shores on Bogue Banks, and CALO on Shackleford Banks provide recreational activities for residents and visitors, including beachcombing, fishing, swimming, kayaking and other beach activities.

Shackleford Banks supports one of the best and most unique surfing spots on the East Coast of the United States (Personal Communication, Doug Piatkowski, Biologist US Army Corps of Engineers (now with Bureau of Ocean Energy Management), 4 May 2011). Though it does not break all of the time, when the conditions are right, local and national pro surfers will travel long distances to surf this unique wave. The undeveloped nature of the island makes access difficult; however, on a good day the island can host over 200 surfers, photographers, and spectators. Surfers access the island via private boat or ferry. Ferries provide transportation for a fee from Beaufort, North Carolina to Shackleford Banks and are used frequently by recreational visitors, including surfers. Private boats are anchored in open water along the back side of the island and individuals walk across the dunes to the beachfront. There is also access via the National Park Service pier. The primary surf spot is located just east of the Beaufort Inlet spit and extends about 1 mile east along Shackleford Banks.

The south facing angle of the island provides a perfect set up for a south to southeast swell and northeast winds. Large swell generated via low pressure systems or hurricanes (June through November) from the south to southeast direction will come from deep water and hit the shallow nearshore sand bars, creating large plunging waves. A northeast wind direction is offshore on Shackleford Banks and will create clean and “glassy” surface conditions. The steep plunging waves and offshore wind direction create a fast and “barreling” beach break wave which is very unique to North Carolina and, with the right conditions, is one of the best spots on the East Coast.

4.11 Recreational and Commercial Fishing

Commercial and recreational fishing are important industries along Bogue and Shackleford Banks. In Carteret County there are several major centers of fishing activity, recreational and commercial fishing centers at Morehead City and Beaufort. The project area is heavily used by all fishing interests including surf and pier fishermen, charter boats, and commercial gill-netters and trawlers. Important commercial species include menhaden, thread herring, croaker, and summer flounder. Total commercial landings utilizing Morehead City and Beaufort during 2008 was about 2.9 million pounds at a commercial value of $6.8 million (Personal Communication, Ms. Grace Kemp, Biologist, NC Division of Marine Fisheries, December 1, 2010).

The beaches of Bogue Banks are used by off-road vehicles (ORVs) and surf fishermen. These two interests constitute the major user groups of the project area and contribute to the local economy. The use of ORVs on Bogue Banks beaches is generally restricted to the months of October-April; however numerous public beach access points are available for foot travel year-round. These ORVs are generally not allowed for the general public on Shackleford Banks except for contractors working on the island.

The Oceana and Doubletree Hotel piers are located in the Town of Atlantic Beach, which is within the proposed project limits. These ocean piers, private recreational vessels, and charter boats that use the nearshore waters also contribute to the local economy. There are no ocean piers on Shackleford Banks but the NPS maintains a small service access pier on Back Sound. This NPS pier is not open for public fishing or recreational use.

4.12 Socioeconomics

Carteret County is located on the lower coastal plain of eastern North Carolina. The county seat of Beaufort lies 150 miles east of Raleigh and 90 miles north of Wilmington, North Carolina. The principal industries are tourism, construction, services, sport and commercial fisheries. The County is also home to a growing retirement population attracted to the area by a mild climate and beautiful natural surroundings. Tourism is generated by the 65 miles of south-facing beaches, Fort Macon State Park, NC Aquarium, NC Maritime Museum, and Cape Lookout National Seashore. Large numbers of vacation homes, motels, restaurants, and shopping centers have been developed to serve the local, retirement, and tourist populations. Additional economic data on the Morehead City Port is found in Section 3.3.2 of the DMMP.

Base Socioeconomic Conditions. From 2000 to 2010, the population of Carteret County grew at a rate of about 12% (i.e., 2000 population was 59,404 and 2010 population was 66,469). About 40% of the residents live in one of the County’s municipalities. With its overwhelming economic emphasis on tourism, retail sales in Carteret County comprise the most important source of jobs and income for the County's economy. In 2007, total crop sales for Carteret County were over 20 million dollars, with corn and soybeans as the leading commodities.

Table 4-10 shows the populations of the beach towns and Carteret County since 2000.

Town/County/State	2000 Population	2010 Population
Atlantic Beach	789	1,495
Pine Knoll Shores	1,524	1,337
Indian Beach	95	112
Morehead City	7,691	8,661
Carteret County	59,404	66,469
North Carolina	8,046,813	9,535,483

Table 4-10. Population Statistics, Carteret County, and North Carolina

Projected Population: Carteret County population projections for 2010 – 2030 are shown in Table 4-11.

County/State	2010 Population	2020 Population	2030 Population
Carteret	66,469	69,157	71,852
North Carolina	9,535,483	10,966,956	12,465,481

Table 4-11. Population Projections, Carteret County, North Carolina
(Source: Office of State Planning, State of North Carolina)

Minority and Low Income Populations (includes Children). In 2014, Carteret County was racially composed of 89.8% White, 6.3% Black, 4.0% Hispanic, 0.6% American Indian, 1.2% Asian, and 0.1% Native Hawaiian or Pacific Islander, and about 2.0% of the population identify with two or more races (US Census quickfacts 2014). Please note, the total racial percent of the population may be greater than 100% because Hispanic may be identified in more than one group.

Any individual with total income less than an amount deemed to be sufficient to purchase basic needs of food, shelter, clothing, and other essential goods and services is classified as poor. The amount of income necessary to purchase these basic needs is the poverty line or threshold and is set by the Office of Management and Budget (US Census 2014). The 2014 poverty line for an individual under 65 years of age was $12,316. The poverty line for a three-person family with one child and two adults was $19,055. For a family with two adults and three children, the poverty line was $28,252 (US Census quickfacts 2014).

Carteret County per capita income for 2013 was $27,496 and the median household income for 2013 was $46,534. In 2013, in North Carolina, the per capita income was $25,284 and the median household income was $46,334. In 2013 the poverty rate in Carteret County was around 14.4%, and for children ages 0-17 the poverty rate increased to 18.9%. In 2013 the poverty rate in North Carolina was 17.5% and for children ages 0 to 17 the poverty rate was 22.5% (US Census quickfacts 2014).

In Carteret County, persons under 18 years old are about 19.2% of the population or about 12,762. Student enrollment for the 2010-2011 school year is about 8,694 in pre-kindergarten through 12th grade. There are ten elementary, five middle, and four high schools in Carteret County (Carteret County Schools, 2014).

In 2011, Carteret County manages 14 parks and 3 County school ball fields, ranging in size from 1 to 31 acres, located from Sea Level to Cedar Point, totaling approximately 200 acres (Carteret County Parks Department 2011). Carteret General Hospital in Morehead City is the only hospital in Carteret County.

Projected State and Regional Population: The State of North Carolina and the seventeen-county region around the Port of Morehead City are both important to the activity of the Port. Much of the activity of the Port is related to industries and military facilities in the region. From 2000 to 2010, the State grew at an annual rate of 1.7 percent and the region grew at a rate of 1.2%. In the 5-year period from 2009 to 2014, the State is projected to continue to grow at a rate 1.7%, while the region is expected to slow to only 0.1%. Over the 15-year period from 2014 to 2029, the State is projected to grow at 1.5% annually and the Region at a rate of 0.6%. The Port is an important asset in an area of the State that needs jobs and economic growth.

4.13 Other Significant Resources (Section 122, P.L. 91-611)

Section 122 of P.L. 91-611 identifies other significant resources which must be considered during project development. These resources, and their occurrence in the study area, are described below.

4.13.1 Air, Noise, and Water Pollution

a. Air Quality. The ambient air quality for Carteret County has been determined to be in compliance with the National Ambient Air Quality Standards, and this county is designated as an attainment area Section 4.4 provides additional information on this subject.

b. Noise. Noise is a prominent feature in the study area because of the sound of the breakers and at times, tourists, the Port of Morehead City Harbor, and traffic on the beach. The sounds of breakers are tranquil and add to the pleasure experienced by visitors on both Bogue and Shackleford Banks. The relatively low human presence on Shackleford Banks reflects a lower noise level than the urban and developed Bogue Banks. Complaints of municipal residents concerning noise in the downtown area of Morehead City due to the port and urban traffic as well as the towns on Bogue Banks are normal. However, these towns on the mainland and Bogue Banks do not experience a problem to the extent that maximum densities for residential dwellings have been established nor have noise level reduction standards (outdoor to indoor or indoor to outdoor) been established. Other than the Port of Morehead City, no large manufacturing, industrial, or mining-type operations are located in the project area. No major airports or other area establishments or entities are affecting unbearable noise levels on the community (Carteret County 2010). The Town of Morehead City has a Noise Ordinance Code (Code 1973, § 13-37; Ord. No. 1987-03, 4-14-87) that is enforced 24 hours a day (Town of Morehead City 2009).

Any harbor or open-water coastal environment has a number of underwater ambient noise sources such as commercial and recreational vessel traffic, dredges, wharf/dock construction (e.g., pile driving), natural sounds (e.g., storms, biological), and so on. To better assess potential species effects (i.e., disturbance of communication among marine mammals) associated with dredge-specific noise from navigation maintenance, deepening, or borrow area dredging operations, Clarke et al. (2002) performed underwater field investigations to characterize sounds emitted by bucket, hydraulic cutterhead, and hopper dredge operations. A summary of results from the study are presented below and are a first step toward developing a dredge sounds database that will encompass a range of dredge plant sizes and operational features:

Cutterhead Suction Dredge
Noise generated by a cutterhead suction dredge is continuous and muted and results from the cutterhead rotating within the bottom sediment and from the pumps used to transport the effluent to the disposal area. The majority of the sound generated was from 70 to 1,000 hertz (Hz) and peaked at 100 to 110 decibel (dB) range. Although attenuation calculations were not completed, reported field observations indicate that the cutterhead suction dredge became almost inaudible at about 500 meters (Clarke et al., 2002).

Hopper Dredge
The noise generated from a hopper dredge is similar to a cutterhead suction dredge except there is no rotating cutterhead. The majority of the noise is generated from the drag arm sliding along the bottom, the pumps filling the hopper, and operation of the ship engine/propeller. Similar to the cutterhead suction dredge, most of the produced sound energy fell within the 70- to 1,000-Hz range; however peak pressure levels were at 120 to 140 dB (Clarke et al., 2002).

Bucket Dredge
Bucket dredges are relatively stationary and produce a repetitive sequence of sounds generated by winches, bucket impact with the substrate, bucket closing, and bucket emptying. The noise generated from a mechanical dredge entails lowering the open bucket through the water column, closing the bucket after impact on the bottom, lifting the closed bucket up through the water column, and emptying the bucket into an adjacent barge. On the basis of the data collected for this study, which included dredging of coarse sands and gravel, the maximum noise spike occurs when the bucket hits the bottom (120 dB peak amplitude). A reduction of 30 dB re 1 µPa/m occurred between the 150 m and 5,000 m listening stations with faintly audible sounds at 7 km. All other noises from the operation (i.e., winch motor, spuds) were relatively insignificant (Clarke et al., 2002).

c. Water quality. The existing water quality in the project area is relatively good. Section 4.3.01 further discusses this subject.

4.13.2 Man-made and Natural Resources, Aesthetic Values, Community Cohesion, and Availability of Public Facilities and Services

Dredging in the Morehead City Harbor navigation channels is not expected to cause significant interference with commercial and recreational boat traffic. The mobility of a hopper dredge will preclude any interference with regular commercial ship traffic as a result of travel to and from the navigation channels. Should a hydraulic pipeline dredge be used, the pipeline from the navigation channels to Brandt Island, the beach disposal areas, or the nearshore placement areas will be submerged until it reaches nearshore waters off Bogue and Shackleford Banks or within the pipeline corridor on Atlantic Beach. The pipeline would be marked to let commercial and recreational boaters know of its presence along the bottom. Work barges and other appurtenances associated with a pipeline dredge operating in open water would be moored so as to minimize interference with boat traffic in the area.

The Oceana and Doubletree piers are located in the Town of Atlantic Beach, which are within the proposed project area. During past beach disposal events, a 100-yard buffer on either side of these ocean piers was maintained so as not to adversely impact these structures.

4.13.3 Hazardous, Toxic, and Radioactive Wastes (HTRW)

No HTRW are found within the project area. HTRW is thoroughly discussed in Section 4.2.

4.14 Employment, Tax, and Property Value

In March 2011, Carteret County had a total labor force of 31,895 of which 29,079 were employed and 31,895 was unemployed. For this same date, in North Carolina the total labor force was 4,478,433 of which 4,043,437 were employed and 434,966 were unemployed. In March 2011, the employment rate in Carteret County was 8.8% and in North Carolina was 9.7% (NC ESC 2011).

Carteret County historically has one of the lowest property tax rates in North Carolina, and the 2010 tax rate of $.23/$100 valuation is the lowest rate of any North Carolina county (CEDC 2011).

The study area is a major resort area in Carteret County. Property values contribute to the tax base. The tax base of the first row of oceanfront properties found in Atlantic Beach, Pine Knoll Shores, Indian Beach (includes Salter Path) and Emerald Isle are 38 %, 47 %, 56 %, and 31 % respectively (Personnel Communication, Ralph Foster, Assistant Carteret County Tax Administrator, December 1, 2009).

4.15 Displacement of People, Businesses, and Farms

No people, homes or businesses will be displaced by the proposed DMMP or No Action plan. There will be no utility relocations. There are no farms in the project area which would be affected by the proposed DMMP or the No Action plan.

4.16 Community and Regional Growth

Communities in the Morehead City Harbor vicinity have been experiencing rapid growth during the last few decades (see detailed discussion in Section 4.13

Socioeconomics, above). This growth is expected to continue with or without the proposed DMMP or No Action plan.

5 ENVIRONMENTAL CONSEQUENCES OF THE RECOMMENDED PLAN AND THE NO ACTION ALTERNATIVE

The following section discusses and compares the environmental effects of the proposed DMMP and the No Action alternative in the Morehead City Harbor project area. The Morehead City Harbor navigation channels are to be maintained to their authorized depth and width. No expansion (i.e., greater depth or width) of the federal navigation channels is planned at this time. A complete project description is found in Section 3.4.2, Summary of Base Plan.

The affected environment of the project area includes the Brandt Island upland diked disposal area, the beaches of Bogue Banks (i.e., Fort Macon State Park, the Towns of Atlantic Beach and Pine Knoll Shores), and the waters adjacent to these areas, including Shackleford Banks, as described below.

Table 5-1 summarizes and compares the potential environmental effects of the recommended plan and the No Action alternative:

Resource	Recommended Alternative - Proposed DMMP	No Action Alternative
Sediment and Sand	• Positive: Reduce Beaufort Inlet Ebb Tide Delta deflation that is related to maintenance dredging within the federal navigation channels. • Positive: Coarse-grained dredged material (≥90% sand) placement on the beaches of Bogue Banks and in nearshore areas off Shackleford and Bogue Banks within the Inlet Influence area will ameliorate sediment losses from the ebb tide delta.	• Negative: Deflation within the Beaufort Inlet Ebb Tide Delta would continue at current rates, potentially leading to wave-induced shoreline impacts along Bogue and Shackleford Banks. • Negative: Coarse-grained dredged material (≥90% sand) placement on Bogue Banks beaches and the existing Nearshore West will only decrease losses within the western lobe of the ebb tide delta and along the eastern end of Bogue Banks. No improvement to the eastern lobe of the ebb tide delta or Shackleford Banks beach.
Water Quality	• Positive: No long-term adverse impacts on the water quality. • Negative: Transient and minor increases in turbidity during maintenance dredging and dredged material disposal • Positive: Control of turbidity during dewatering of Brandt Island	• Positive: No long-term adverse impacts on the water quality. • Negative: Transient and minor increases in turbidity during dredging and dredged material disposal • Positive: Control of turbidity during dewatering of Brandt Island
Air Quality	• . Positive: No adverse effect on air quality	• Positive: No adverse effect on air quality
Marine Biota	• Negative: Temporary displacement of fish and other biota in the expanded Nearshore West and Nearshore East Placement Areas (ebb-tide delta). • Negative: Temporary disturbance of benthic organisms within ODMDS and/or nearshore placement areas. Localized, short-term, and reversible adverse impacts to intertidal macrofauna (beach infauna). • Positive: Benthic organisms will decolonize areas following disposal. Beach placement will occur once every three years. • Positive: Coarse-grained material (≥90% sand) placed on Bogue Banks beaches will minimize impacts to intertidal macrofauna. • Positive: No long-term adverse impacts to marine biota	• Negative: Temporary displacement of fish and other biota in the existing Nearshore West Placement Area (ebb-tide delta). • Negative: Localized, short-term, and reversible adverse impacts to intertidal macrofauna (beach infauna). • Negative: Temporary disturbance of benthic organisms within ODMDS or Nearshore West. Benthic organisms will decolonize areas following placement. Beach placement will occur once every three years. Coarse-grained dredged material (≥90% sand) placed on beaches will minimize impacts to intertidal macrofauna • Positive: No long-term adverse impacts to marine biota
Essential Fish Habitat	• Negative: Temporary displacement of species during dredging and placement of dredged material along the beach strand and the nearshore placement areas (ebb-tide delta) • Positive: No permanent adverse impacts	• Negative: Temporary displacement of species during dredging and placement of dredged material along the beach strand and existing Nearshore West Placement Area (ebb-tide delta) • Positive: No permanent adverse impacts
Terrestrial Biota	• Negative: Potential displacement of species during disposal of dredged material in Brandt Island, on Bogue Banks beaches. • Positive: Positive benefit of placement of coarse-grained material (≥90% sand) on Bogue Banks by reducing long-term erosion	• Negative: Potential displacement of species during disposal of dredged material in Brandt Island or on Bogue Banks beaches • Positive: Positive benefit to placement of coarse-grained sediment on Bogue Banks by reducing long-term erosion
Cultural Resources	• Positive: No impacts to known cultural resources	• Positive: No impacts to known cultural resources
Aesthetic and Recreational Resources (Bogue Banks) **Cape Lookout National Seashore (NPS)**	• Negative: Short-term closure of beach areas on Bogue Banks during beach placement operations. • Negative: Temporary aesthetic changes due to pipeline on beach during beach placement • Positive: Long-term improvement to aesthetics and recreation due to beach placement of sand • No changes to Shackleford Banks Beach	• Negative: Short-term closure of beach areas during beach-fill operations. • Negative: Temporary aesthetic changes due to pipeline on beach during beach-fill. • No changes to Shackleford Banks Beach

Table 5-1. Summary of Potential Environmental and Socioeconomic Consequences

Resource	Recommended Alternative - Proposed DMMP	No Action Alternative
Recreational and Commercial Fishing	• Negative: Temporary displacement from the vicinity of dredging or placement activities • Positive Consequences: No permanent adverse impacts	• Negative: Temporary displacement from the vicinity of dredging or placement activities • Positive: No permanent adverse impacts
Socioeconomic Resources	• Positive: Increased sand placement on the beaches of Bogue Banks may contribute to increased beach real estate values. • Negative: Placement of sand on Bogue Banks may result in short-term adverse impacts during beach placement. • Positive: Bogue Banks should experience long-term benefits by reducing anthropogenic effects and increasing benefits to visitor use, experience, and tourism in the area. • Positive: No permanent adverse impacts	• Negative: Sand placement would continue to occur only on Bogue Banks Shackleford Banks would not experience long-term benefits by reducing anthropogenic effects. • Positive: Sand placement may contribute to increased beach related values, reduce anthropogenic effects, increase benefits to visitor use, experience, and tourism on Bogue Banks. • Positive: No permanent adverse impacts
Other Significant Resources (Section 122, P.L. 91-611)	• Positive: No HTRW sites are located in the project area. No sediments in the navigation channel contain contaminants above regulatory levels. • Negative: Temporary increases in noise related to dredging and beach placement activities. • Positive: No permanent adverse impacts for air and water quality and noise	• Positive: No HTRW sites are located in the project area. No sediments in the navigation channel contain contaminants above regulatory levels. • Negative: Temporary increases in noise related to dredging and beach placement activities. • Positive: No permanent adverse impacts for air and water quality and noise

Table 5-1 (continued). Summary of Potential Environmental and Socioeconomic Consequences

5.1 Physical Resources

5.1.1 Sediment and Sand

Proposed DMMP. The characteristics of the dredged material dictate where disposal of that material will be permitted. Simply, fine-grained materials (less than 90% sand) would be disposed of in Brandt Island (upland confined disposal area) or in the ODMDS. The Nearshore East and West placement areas could be used for coarse-grained sandy material (sediments ≥ 90% sand). Benthic sediment analyses of these nearshore placement areas indicated that predominantly sandy material would be acceptable for placement there. Coarse-grained sediments (sediments ≥90% sand) would be placed on the beaches of Bogue Banks or in the Nearshore East and West. Sand placement along Shackleford Banks is part of the USACE recommended plan; however, at the request of the NPS, no sediment will be placed on Shackleford Banks as part of this DMMP. Some coarse-grained material may be disposed of in the ODMDS when inclement weather hinders hopper dredge placement in the nearshore; however, future dredging contracts will include requirements that limit this practice.

The placement of dredged material on the ebb tide delta, which is part of the littoral system, is expected to contribute to the stability of the ebb tide delta thus positively affecting the littoral system and the associated features. Disposal of material directly on the beach would contribute to improvement of beach stability. However, any time dredged material is not placed in the ebb tide delta, it may adversely affect the deflating ebb tide delta. An understanding of coastal inlet processes suggests that continued erosion of the ebb tide delta complex is likely to eventually impact the adjacent beaches. The mechanisms of ebb tide delta deflation that would lead to impacts to the adjacent beaches include: (1) increased wave heights and changes to their approach angles as a result of changes in the offshore wave transformation, which would result in increased shoreline erosion and volumetric losses of sand along the beach; and (2) changes in longshore transport rates and flow paths of sediment would also be expected.

A comprehensive monitoring program, as outlined in Appendix F, Morehead City Harbor Monitoring Plan, will allow the USACE to assess ongoing operations and provide guidance regarding the need for possible modification of future dredging practices to maximize efficacy of dredged material disposal within the system.

As indicated in Section 4.1, there are no known sediment contaminants in the Morehead City Harbor maintenance dredged material, therefore, no sediments with contaminants above regulatory levels would be placed in any disposal areas found within the project area.

No Action Alternative. Inner Harbor material would be disposed in Brandt Island or the ODMDS.

Outer Harbor coarse-grained dredged material would be placed on the beaches of Bogue Banks and/or the existing Nearshore West Placement Area off Bogue Banks. Some coarse-grained material may be disposed in the ODMDS during inclement weather. Outer Harbor Entrance channel material would be disposed of within the ODMDS.

The placement of sand on the ebb-tide delta, which is part of the littoral system, is expected to contribute to the stability only of the western lobe of the ebb-tide delta. Placement of material directly on the beach would contribute to improvement of beach stability only for the beaches of Bogue Banks.

Impacts of the No Action plan on sediment resources would be the similar as those of the proposed plan, however, impacts would be expected to be somewhat greater as the No Action plan does not include the proposed Nearshore East Placement Area off Shackleford Banks, which would help balance placement in the ebb tide delta. Deflation within the Beaufort Inlet Ebb Tide Delta would continue most likely at current rates, potentially leading to wave-induced shoreline impacts especially along Bogue and Shackleford Banks. Coarse-grained sand placement on the beaches and the existing Nearshore West Placement Area off Bogue Banks within the Inlet Influence area will only decrease losses within the western lobe of the ebb tide delta and along the eastern end of Bogue Banks. No improvement to the eastern lobe of the ebb tide delta off Shackleford Banks will occur. Also, the No Action plan does not include expansion of the Nearshore West.

There are no known sediment contaminants in the Morehead City Harbor maintenance material therefore the No Action Plan will not place sediments with contaminants above regulatory levels in any disposal areas found within the project area.

5.1.2 Sediment Characteristics

Dredged material from the Morehead City Harbor project has been placed on the beaches of Bogue Banks periodically since 1978 and sediment compatibility has not been an issue. Dredged material from the Morehead City project has never been placed on Shackleford Banks and therefore a more detailed analysis of the material dredged compared to the native beach on Shackleford Island was performed to confirm that dredged material from the Harbor would be a good match for that beach as well. The following discussion in this section clearly explains the criteria used to determine sediment compatibility.

The information mentioned in this section is summarized from the following sources: USACE 2002b, USACE 2008b, and USACE 2011.

If the dredged material from the Morehead City Harbor is placed on Shackleford Banks, the placement would generally take place from about the base of the dune (DB) to the -24 ft depth of the beach profile.

From the sediment analysis and surveys (USACE 2008b, USACE 2002b, and USACE 2011) the following conclusions can be made.

a. Grain size analysis. On Shackleford Banks, the mean grain size of beach sediments from the DB to the mean low water contour and from the trough to the -24 foot depth is 0.532 mm and 0.250 mm respectively. The maintenance sediment from the Morehead City Harbor federal navigation channels had a mean grain size of 0.267 mm. The frequency distributions of Shackleford Banks sediments from the TR to -24 ft portion of the beach were similar to the grain size distributions of the Morehead City Harbor sediments considered for beach placement. The DB to -24 ft grain size frequency distribution for Shackleford sediments were slightly more negatively skewed (coarser) and flatter (less kurtosis) than the Morehead City Harbor sediment distribution. Shackleford Banks sediments above the bar were typically coarser than Morehead City Outer Harbor sediments and particularly so in the surf zone. The Shackleford Banks dune, dune base, and berm crest (mean grain sizes of 0.306 mm, 0.338 mm, and 0.359 mm respectively) were also coarser than Morehead City Harbor sediments (0.267 mm) but not as different as the beach sediments that included surf zone portions of the beach. The Morehead City Harbor sediments had slightly more silt content (passing #230 sieve) at 3.6% vs. 1.0% from the Shackleford Banks DB to -24 ft sediment. The maintenance sediment from the Morehead City Harbor federal navigation channel has slightly more visual shell content (16.0% vs. 13.9% DB to the -24 foot depth on Shackleford) than the native beach on Shackleford Banks.

On Shackleford Banks, the standard deviation of the native sediment from the base of the dune to the mean low water contour and from the trough to the -24 foot depth is 1.29 phi and 0.88 phi, respectively. The Morehead City Harbor sediments had a standard deviation of 0.84 phi. These differences mean that both sediments are moderately sorted and the Shackleford sediments are less sorted than the Morehead City Outer Harbor sediments.

Sediments used to replace natural beach sand should match the natural beach as closely as possible in order to minimize environmental effects. While the scientific literature agrees with this statement in principle, there is little data available to quantify precisely what similarity (or difference) is ecologically significant. Morehead City Outer Harbor sediments at the time of disposal would be similar in terms of grain size distributions to portions of the Shackleford beach profile (specifically the submarine portions of the beach profile) and finer than other portions (specifically the subaerial portions of the beach). Morehead City Harbor sediments placed on Shackleford Banks would be mobilized and redistributed under a variety of environmental conditions including winds, waves, longshore currents, offshore currents, and tides. As sand travels from the beach to the dunes, the coarse end of the placed sediment would likely lag behind, rendering the size curves better sorted and also positively skewed.

Over the long term, the speed and degree of ecological recovery largely depend on the physical characteristics of the beach habitat, mainly determined by (1) sediment quality and quantity, (2) the disposal technique and strategy applied, (3) the location and the size of disposal and (4) the physical environment prior to placement (Speybroeck, J. et al. 2006).

b. Color analysis. The maintenance sediment from the Morehead City Harbor federal navigation channel is slightly redder in hue (10 YR vs. 2.5 Y), slightly lighter in value (8 vs. 7), and slightly grayer in chroma (1 vs. 2) than the Shackleford Banks native beach.

The majority of the sediment from the federal navigation channel is only one increment higher or lighter than the native Shackleford beach (i.e., 8 vs. 7 on the native beach).

From the Munsell hue, value, and chroma measurements, there does not appear to be a significant difference between the color of the Shackleford native beach and the dredged sediment from the federal navigation channel.

Other Considerations

Two other considerations discussed in the following paragraphs are used to provide additional information regarding the sediment compatibility; however, neither of these considerations represent requirements that directly apply to the disposal of dredged material from the Morehead City Harbor federal navigation project.

1. NC Technical Standards. The State of North Carolina's Coastal Management Program includes 15A NCAC 07H .0312 TECHNICAL STANDARDS FOR BEACH FILL PROJECTS (hereafter the NC Technical Standards). Beach fill projects include beach nourishment, dredged material disposal, habitat restoration, storm protection, and erosion control. However, the NC Technical Standards do not apply to the beach placement of sediment directly from and completely confined to a federally or state maintained navigation channel. These standards also do not apply to any Federal project at this time. The purpose of the discussion of the NC Technical Standards in this DMMP is to provide additional information regarding the compatibility of dredged material from the Morehead City Harbor channel with the adjacent beaches.

The Shackleford Banks beach was sampled using methods similar to those specified in the NC Technical Standards (07 H.0312 (1)(c) and (d). The Morehead City DMMP sampling of Shackleford included about 14 sediment samples were taken along each of 46 shore-perpendicular transects (from the beach dune to -30 foot elevation) about every 1,000 feet of shoreline on Shackleford Banks from Barden (Transect 00) to Beaufort (Transect 460) Inlets. Five samples were taken above MLW and eight samples were taken below MLW on Shackleford. The NC Technical Standards require a minimum of 5 shore perpendicular transects evenly spaced throughout the entire project area (but spaced no more than 5000 feet apart). The NC Technical Standards require transect to extend from the frontal dune crest seaward to a depth of -20 feet (6.1 meters) or to the shore-perpendicular distance 2,400 ft seaward of mean low water, whichever is in a more landward position. The total number of samples taken landward of MLW shall equal the total number of samples taken seaward of MLW.

Specific grain size analysis categories and composite approaches are required by the NC Technical Standards. These were performed for the Shackleford samples.

The NC Technical Standards indicate that sediment is compatible for use as beach fill if the following five criteria (i.e., a through e, below) are met:

a. Fine-grained (less than 0.0625 mm) sediment is less than 10%,

b. The average percentage of fine-grained (less than 0.0625 mm) sediment is less than 5% of the recipient beach, and

c. The average percentage of calcium carbonate (% shell) does not exceed 15% of the recipient beach.

d. The average percentage by weight of granular sediment (greater than or equal to 2 mm and less equal to 4.76 mm) in a borrow site shall not exceed the average percentage by weight of coarse sand sediment of the recipient beach characterization plus 5%.

e. The average percentage by weight of gravel (greater than or equal to 4.76 mm) in a borrow site shall not exceed the average percentage by weight of gravel sized sediment for the recipient beach characterization plus 5%.

Table 5-2 below summarizes information applicable to the NC Technical Standards and all data found in Table 5-2 is summarized from USACE 2002b, USACE 2008b, and USACE 2011. For all sediment samples on Bogue Banks, Shackleford Banks, and the Morehead City Harbor dredged material the percentage of shell (% visual shell) was visually estimated during the sieving procedure. The following paragraphs describe how the proposed action complies with the NC Technical Standards:

a. and b. The Morehead City Harbor sediments contain less than 10% fines (3.6% passing the #230 sieve (0.063 mm). The Shackleford dune (DN) to -

24 ft data composite best matches the frontal dune to -20 ft depth sampling composite described in the NC Technical Standards. This Shackleford composite (recipient beach) contained 1.0% #230 fines. The Harbor sediment is less than 5% of the Shackleford sediment (i.e., 3.6% is less than 6% (1% plus 5% = 6%)).

c. The Morehead City Harbor sediment contains 16.0% visual shell. The Shackleford dune (DN) to -24 ft data composite best matches the frontal dune to -20 ft depth sampling composite described in the NC Technical Standards. This Shackleford composite (recipient beach) contained 13.9% visual shell. The Harbor sediment does not exceed 15% of the recipient beach (i.e., 16.0% is less than 28.9% (13.9% + 15% = 28.9%)).

d. Sediment which is greater (coarser) than or equal to 2 mm and less (finer) than 4.76 mm is the difference between that retained by the # 10 sieve (2.0 mm) and the #4 sieve (4.76 mm). For the Morehead City Harbor sediment the percent passing #4 sieve is 98.1% and passing #10 is 95.4%, a difference of 2.7%. For Shackleford Banks (DN to -24 depth) the percent passing the #4 sieve is 96.6% and passing the #10 sieve is 92.5%, a difference of 4.1%. The Harbor sediment is Less than 5% of the Shackleford sediment (i.e., 2.7% is less than 9.1% (4.1% plus 5% = 9.1%)).

e. The sieve size of gravel (greater than or equal to 4.76 mm) is greater than the #4 sieve. The Morehead City Harbor sediment percent passing the #4 sieve is 98.1 and Shackleford Banks (DN to -24 foot depth) is 96.6. That means that the Harbor sediment is 1.9% (100 - 98.1 = 1.9%). Shackleford Banks is 3.4% (100 - 96.6 = 3.4%). Again the Harbor sediment is LESS THAN 5% of the Shackleford sediment (i.e., 1.9% is less than 8.4% (3.4% plus 5% or 8.4%).

Sediment	No. of Samples	mm	phi	Std Dev phi	% Passing #4 sieve nominal size 4.76 mm	%Passing #10 sieve nominal size -2.00 mm	% Passing #200 sieve nominal size -0.074 mm	% Passing #230 sieve nominal size -0.063 mm	%Visual Shell
Morehead City Outer Harbor Channel Sediments	130	0.267	1.90	0.84	98.1	95.4	3.6	3.6	16.0
Shackleford Banks Data All	647	0.323	1.63	1.10	96.7	92.9	1.9	1.5	12.3
Shackleford Banks Data DN to -24 ft	598	0.339	1.56	1.13	96.6	92.5	1.2	1.0	13.0
Shackleford Banks Data DB to -24 ft	552	0.344	1.54	1.20	96.3	91.9	1.3	1.0	13.9
Shackleford Banks Data DB to MLW	230	0.532	0.91	1.29	94.2	87.1	0.4	0.4	22.2
Shackleford Banks Data TR to -24 ft	322	0.25	2.00	0.88	97.8	95.3	1.9	1.5	8.0
Ft Macon	34	0.213	2.23	0.80	NR	99.0	1.6	NR	10.9
Atlantic Beach	82	0.183	2.45	0.79	NR	98.7	3.4	NR	7.1
Pine Knoll Shores	102	0.188	2.41	0.81	NR	98.4	3.6	NR	8.9
Indian Beach	34	0.205	2.28	0.93	NR	98.2	3.2	NR	10.9
East Emerald Isle	47	0.203	2.30	0.74	NR	98.8	2.6	NR	6.3
West Emerald Isle	67	0.193	2.37	0.68	NR	98.7	2.4	NR	4.9
Bogue Inlet Area	51	0.189	2.40	0.52	NR	98.9	1.9	NR	4.0

Table 5-2. Sediment Data Applicable to the North Carolina Technical Standards. All sediment data taken from USACE 2002b, USACE 2008b, and USACE 2011.

2. Overfill Ratio or Factor. An overfill factor is a tool commonly used to evaluate the compatibility of sediments and to relate the volume of disposed sediment required for a project to perform similarly or comparably to the native beach sand. Overfill factors are used predominantly for projects that involve the construction of a dune or berm with specific performance requirements. For this reason, overfill factors do not specifically apply to the DMMP placement of dredged material from the Morehead City Harbor federal navigation project on adjacent beaches. However overfill factors are useful in demonstrating the degree of compatibility between material dredged from the Morehead City Harbor channel and the adjacent beaches. As an example, an "overfill" factor of 1.0 indicates direct compatibility (that is, borrow and native sands are identical) and an "overfill" factor of 1.1 indicates that the borrow site material is finer and thus 10 percent additional material disposal (coverage) is required to compensate for the incompatibility and expected loss of fine sediments. In other cases, the sediment size is predetermined because the sand is a by-product of a channel maintenance project, and thus the design professional is evaluating only how the beach will respond.

There are a number of methods used to compute the overfill ratios, these include: Dean's (1991) Equilibrium Profile Method (EPM) and Pilarczyk, Van Overeem, and Bakker's (1986) Equilibrium Slope Method (ESM). Table 5-3 shows the results of the Dean's (1991) EPM and Pilarczyk et al (1986) ESM methods of calculating the overfill ratios for the disposal of Morehead City Harbor sediment on Shackleford Banks. Both EPM and ESM overfill ratios used the sediment data taken from USACE 2008a and USACE 2011. The range of the overfill ratios are from 1.22 to 1.49. The USACE believes that Dean's (1991) EPM overfill ratio of 1.22 is considered to be the most reliable overfill ration based on previous engineering experience and results. Dean's (1991) EPM includes mathematical terms which take into consideration the fill height, the fill width, the significant wave height along with the native beach, and fill grain size mean and standard deviation.

Overfill Ratio[1]	**MEAN (phi)**	**STD DEV (phi)**	**EPM**[2]	**ESM**[3]
Morehead City Outer Harbor	1.90	0.84	NA	NA
Shackleford Banks Native Data DN to -24	1.56	1.13	1.22	1.49
[1] Assumed: Berm Height = 6' Berm Width = 150' Significant Wave Height = 6.2'				
[2] Dean's (1991) Equilibrium Method				
[3] Pilarczyk et al. (1986) Equilibrium Slope Method				

Table 5-3. Summary of Overfill ratios Calculated for the Disposal of Sediment on Shackleford Banks. All calculations used sediment data from USACE 2008b and 2011.

Proposed DMMP. The USACE believes that the placement of suitable maintenance dredged material from the portions of Range C, Range B, the Cutoff and Range A (to station 105+00) in Morehead City Harbor onto the beaches of Bogue Banks will not cause an adverse impact to the shoreline. No adverse impacts are anticipated. At the request of NPS no dredged material will be placed on Shackleford Banks.

No Action Alternative. The continued placement of suitable dredged material from the portions of Range C, Range B, the Cutoff and Range A (to station 110+00) in Morehead City Harbor onto Bogue Banks beach will not result in an adverse impact.

5.1.3 Sediment Composition in the Nearshore Placement Areas

Out of the 96 sites sampled, 21.8 % of the sites contained 10.3 % to 61.0 % silt/clay, and 42.7 % had a low silt/clay content (<2% silt/clay). Areas of high silt/clay content (>10% and <61.0%) were found with one large group of sites occurring principally offshore of Shackleford Banks and several smaller areas offshore of Bogue Banks, in water depths ranging from ~20 to 49 feet. Areas of low silt/clay content (less than <2% silt/clan content) predominantly were found along the ebb tide delta and along the nearshore of Bogue and Shackleford Banks. A grouping of these stations also occurs offshore in ~40 feet of water. Three large groups of medium silt/clay content (>2% and <10% silt/clay content) occurred in the mid to nearshore of Shackleford Banks, offshore of the ebb tide delta, and in the mid to nearshore of Bogue Banks.

Proposed DMMP. The placement of dredged material within the nearshore areas of Beaufort Inlet is an important method of reducing the overall deflation of the ebb tide delta. In 1994, the USACE proposed to place suitable sediment from maintenance dredging of the Morehead City Harbor into a nearshore area off Bogue Banks (USACE 1994a and b). Since that time the USACE has disposed of dredged material in the littoral zone west of the Beaufort Inlet (Figure 3-25). The DMMP proposes to place only coarse-grained sand (90% or greater sand) within the nearshore areas off Bogue and Shackleford Banks.

No Action Alternative. The No Action alternative would result in the continued use of the existing and previously approved nearshore placement area off Bogue Banks (USACE 1994 a and b), which would reach capacity before the end of this 20-year DMMP. Currently, suitable maintenance dredged sediment (90% or greater sand) from the portions of Range C, Range B, the Cutoff and Range A (to station 105+00) in Morehead City Harbor is placed off Bogue Banks (Figure 4-1). No significant turbidity impacts have been observed since the placement area is located within the surf zone. Additionally no hardbottoms, benthic resources, and/or any cultural resources have been adversely impacted by the placement of sediment in this area.

5.2 Hazardous and Toxic Waste

Proposed DMMP. The North Carolina State Ports Authority (in NCSPA 2001) reviewed information, published by the United States Environmental Protection Agency (EPA), the North Carolina Department of Environment and Natural Resources (NCDENR), and E Data Resources, Inc. (EDR) (an environmental database search firm). This review was used to determine if any known sites producing, storing, and/or disposing of toxic or hazardous materials have affected or have the potential to affect the Morehead City Harbor project area. The EDR database search (EDR 2010) indicated that no HTRW sites where known hazardous wastes are a concern would be affected by the proposed DMMP.

The DMMP does not involve the placement of sediments with contaminants above regulatory levels in any disposal areas found within the project area. Therefore, the DMMP will have no anticipated adverse impacts to HTRW.

No Action Alternative. There are no areas where known hazardous wastes are a concern that would be affected by the No Action Plan.

The No Action Plan does not involve the placement of sediments with contaminants above regulatory levels in any disposal areas found within the project area.

5.3 Water Resources

5.3.1 Water Quality

Proposed DMMP. Return of effluent from Brandt Island can be controlled such that water released from the diked area has little or no suspended solids. Proper management of releases from Brandt Island will not increase turbidity levels in the area of the spillway pipe outfall above 25 NTUs.

Maintenance dredging in the existing federal navigation channels would involve mechanical disturbance of the bottom substrate and subsequent redeposition of suspended sediment and turbidity generated during dredging. Factors that are known to influence sediment spread and turbidities are grain size, water currents and depths. Monitoring studies done on the impacts of offshore dredging indicate that sediments suspended during offshore are generally localized and rapidly dissipate when dredging ceases (Naqvi and Pullen 1983; Bowen and Marsh 1988; Van Dolah et al. 1992). Some infilling of the federal navigation channels after dredging would be expected from side sloughing of native bottom sediments, which consist of predominately sandy material with a small amount of fine or organic material.

During placement of coarse-grained sediment (90% or greater) along the beaches of Bogue Banks and in the nearshore areas, there would be elevated turbidity and suspended solids in the immediate area of sand deposition when compared to the existing non-storm conditions of the surf zone (Wilber et al. 2006). Significant increases in turbidity are not expected to occur outside the immediate construction/maintenance area (turbidity increases of 25 nephelometric turbidity units [NTUs]) or less are not considered significant). Turbid waters (increased turbidity relative to background levels but not necessarily above 25 NTUs) would hug the shore and be transported with waves either northeast or southwest depending on wind conditions. Because of the low percentage of silt and clay in the coarse-grained sediment (less than 10% for beach disposal and in the nearshore areas), turbidity impacts would not be expected to be greater than the natural increase in turbidity and suspended material that occurs during storm events. Any increases in turbidity in the designated disposal areas for the DMMP would be expected to be temporary and limited to the area surrounding the dredging. Turbidity levels would be expected to return to background levels in the surf zone when dredging ends (Wilber et al. 2006).

On March 19, 2012, the North Carolina Division of Water Resources (NCDWR) reissued general 401 certifications that cover beach placement for Fort Macon State Park, Atlantic Beach, and Pine Knoll Shores (NCDWR Certificate # 3908), nearshore sediment placement off Bogue and Shackleford Banks (NCDWR Certificate # 3908), and release of effluent from upland diked disposal activities (Brandt Island) (NCDWR Certificate # 3888). Copies of these general water quality certificates are found in Appendix D. By letter dated March 14, 2014 from NCDWR, the USACE was given permission to use these general water quality certifications. All conditions and requirements of the water quality certifications will be adhered to in the implementation of the proposed DMMP.

Short term and minor increases in turbidity will occur at the ODMDS. Only dredged material evaluated and found acceptable in accordance with the joint USEPA/USACE guidance (USEPA/USACE 1991 and USEPA/USACE 1993) may be disposed of in the ocean. The guidance evaluates the potential for unacceptable effects such as toxicity or bioaccumulation including water column effects. These required tests reduce the possibilities of unacceptable water column and benthic effects caused by dredged material contaminants (principally associated with fine-grained sediments).

No adverse impacts to water quality in the project area are anticipated.

No Action Alternative. Return of effluent from Brandt Island can be controlled such that water released from the diked area has little or no suspended solids. Proper management of releases from Brandt Island will not increase turbidity levels in the area of the spillway pipe outfall above 25 NTUs.

Placement of the dredged material along the Bogue Banks beaches and the existing Western nearshore area (Ebb Tide Delta), would result in short term and minor increases in turbidity and suspended solids in the nearshore zone. Significant increases in turbidity are not expected to occur outside the immediate construction area (turbidity increases of 25 NTUs or less are not considered significant). Turbid waters (increased turbidity relative to background levels but not necessarily above 25 NTUs) may hug the nearshore and be transported with waves either northeast or southwest depending on wind and current conditions. Turbidity levels are expected to return to background levels in the nearshore zone upon cessation of dredging and placement activities.

On March 19, 2012, the NCDWQ (now NCDWR) reissued general 401 certifications that cover beach placement for Fort Macon State Park and the Town of Atlantic Beach (NCDWR Certificate # 3908), nearshore sediment placement off Bogue and Shackleford Banks (NCDWR Certificate # 3908), and upland diked disposal activities on Brandt Island (NCDWR Certificate # 3888).

Short term and minor increases in turbidity will occur at the ODMDS. Only dredged material evaluated and found acceptable in accordance with the joint USEPA/USACE guidance (USEPA/USACE, 1991 and USEPA/USACE, 1993) may be disposed of in the ocean. The project has been authorized pursuant to Section 103 of the Marine Protection Research and Sanctuaries Act for the transport of the dredged material to the ODMDS. USEPA has concurred that the material is acceptable for ocean disposal.

No long-term adverse impacts to water quality have occurred as a result of maintaining the Morehead City Harbor.

5.3.2 Groundwater

Proposed DMMP. No deepening or widening is being proposed beyond the existing authorized channel dimensions. The DMMP is not anticipated to create any adverse impacts on groundwater within the project area.

No Action Alternative. The No Action alternative maintains the authorized depth and width of the federal navigation channels in the Harbor. No deepening or widening of any federal navigation channels were previously approved. No adverse impacts are anticipated on groundwater within the project area.

5.4 Air Quality

Proposed DMMP. The DMMP is not anticipated to result any adverse effects on the air quality of this attainment area. The project would be in compliance with Section 176 (c) of the CAA, as amended.

Maintenance dredging will occur in roughly the same amount. Temporary increases in exhaust emissions from construction equipment are expected during dredging and dredged material disposal operations. The State of North Carolina does have a State Implementation Plan ("SIP") approved or promulgated under Section 110 of the Clean Air Act, as amended. However, a conformity determination is not required because Carteret County has been designated by the State of North Carolina as an attainment area, and the direct and indirect emissions from the project fall below the prescribed *de minimus* levels (58 Fed. Reg. 93.153(c)(1)) and; therefore, no conformity determination would be required.

No Action Alternative. The No Action alternative would not result in any adverse effect on the air quality in this attainment area and is in compliance with Section 176 (c) of the CAA, as amended.

5. 5 Marine and Estuarine Resources

5.5.1 Nekton

Proposed DMMP. Oceanic nekton are active swimmers, not at the mercy of the currents, and are distributed in the relatively shallow oceanic zone. They are composed of three phyla: chordates, mollusks, and arthropods, with chordates (i.e., fish species) forming the largest portion.

Dredging and the disposal activities within Brandt Island would not result in any significant adverse impacts to the nekton population. The effluent being discharged from Brandt Island into the Inner Harbor will not adversely impact biota.

Any entrainment of adult fish, and other motile animals in the vicinity of the federal navigation channels during dredging would be expected to be minor because of their ability to actively avoid the disturbed areas (Assessment of Potential Larval Entrainment Mortality Due to Hydraulic Dredging of Beaufort Inlet, Settle 2002). Fish species are expected to leave the area temporarily during the dredging operations and return when dredging ceases (Pullen and Naqvi 1983). Larvae and early juvenile stages of many species pose a greater concern than adults because their powers of mobility are either absent or poorly developed, leaving them subject to transport by tides and currents. That physical limitation makes them potentially more susceptible to entrainment by an operating hydraulic dredge (refer to Section 5.5.5, Larval Entrainment). Benthic-oriented organisms close to the dredge draghead could be captured by the effects of its suction field and entrained in the flow of dredged sediment and water. As a worst-case, it could be assumed that entrained animals experience 100% mortality, although some small number might survive. Susceptibility to this effect depends on avoidance reactions of the organism, the efficiency of its swimming ability, its proximity to the draghead, the pumping rate of the dredge, and possibly other factors. Behavioral characteristics of different species in response to factors such as salinity, current, and diurnal phase (daylight versus darkness) are also believed to affect their concentrations in particular locations or strata of the water column. Any benthic-oriented organisms present near the ocean bottom (i.e., calico scallops and spiny dogfish (SAFMC-managed species) would be closer to the dredge draghead and, therefore, subject to higher risk of entrainment.

The biological effect of hydraulic entrainment has been a subject of concern for more than three decades, and numerous studies have been conducted nationwide to assess its effect on early life stages of marine resources, including larval oysters (Carriker et al. 1986), post-larval brown shrimp (Van Dolah et al. 1994), striped bass eggs and larvae (Burton et al. 1992), juvenile salmonid fishes (Buell 1992), and Dungeness crabs (Armstrong et al. 1982). The studies indicate that the primary organisms subject to entrainment by hydraulic dredges are bottom-oriented fishes and shellfishes. The significance of entrainment effects depends on the species present; the number of organisms entrained; the relationship of the number entrained to local, regional, and total population numbers; and the natural mortality rate for the various life stages of a species. Assessing the significance of entrainment is difficult, but most studies indicate that the significance of impact is low. Effects of dredging activities on marine mammals and sea turtles are addressed in the biological assessment (Appendix J). Although entrainment of benthic-oriented organisms would be expected from the proposed dredging activities, a hydraulic dredge operating in the open ocean would pump such a small amount of water in proportion to the surrounding water volume that any entrainment effects associated with dredging of borrow material for the project are not expected to adversely affect species at the population level. In accordance with T&E species observer requirements for hopper dredging activities (Appendix J), inflow screening, as well as observation of dredged material is required to assure accountability of species entrained by the draghead. As a component of hopper dredge observer requirements, all other biota (i.e., fish, bivalves) captured by the inflow screening are recorded and submitted to the USACE for incorporation into a historic entrainment database.

Once maintenance dredging of the federal navigation channels has been completed any temporary short-term entrainment impacts will end. Hydraulic dredges used to maintain the Morehead City Harbor channels operate predominantly when either the cutterhead or the drag-head is in contact with the bottom substrate. The largest pipeline hydraulic dredge that would operate in Morehead City Harbor is about 30-inches in diameter. Comparing the 30-inch diameter pipe to the average cross section of the Harbor, hydraulic entrainment of nekton is not a significant impact. Therefore, the proposed DMMP is not anticipated to adversely impact nekton in the project area.

No Action Alternative. No adverse impacts are anticipated.

5.5.2 Benthic Resources - Beach and Surf Zone

Proposed DMMP. Beach placement of dredged material and beach nourishment have very similar impacts on the beach and surf zone of Bogue Banks. Within this section the terms “placement of dredged material”, “beach disposal”, and “beach nourishment” on impacts to the benthic communities are used interchangeably.

Beach placement and/or nourishment of sediment may have negative effects on intertidal macrofauna through direct burial, increased turbidity in the surf zone, or changes in the sand grain size or beach profile. Literature dating back to the early 1970s along the southeast coast indicate that opportunistic infauna species (e.g., *Emerita* and *Donax*) found in the nourished areas are subject to direct mortality from burial; however, recovery often occurs within one year (Hayden and Dolan 1974; Saloman 1984; Van Dolah et al. 1992; Van Dolah et al. 1993; Jutte et al. 1999) especially if compatible material is placed on the beach (Hayden and Dolan, 1974; Reilly and Bellis 1978; Saloman 1984; Nelson 1989; Van Dolah et al. 1992; Van Dolah et al. 1993; Hackney et al. 1996; Jutte, P.C. et al. 1999; Peterson et al. 2000). In North Carolina, post-nourishment studies have documented similar reductions in abundance of coquina clams (*Donax* spp.), mole crabs (*E. talpoida*), and amphipods (*Haustoriid* spp.) immediately following placement with recovery times persisting between one and three seasons after project construction depending on sediment compatibility (Reilly and Bellis 1983; Peterson et al. 2000a; and Coastal Science Associates, Inc. 2002).

Reilly and Bellis (1978) state, “Beach nourishment virtually destroys existing intertidal macrofauna; however, recovery is rapid once the pumping operation ceases. In most cases, recovery should occur within one or two seasons following the project completion.” Similar findings were reached by Van Dolah (1992) in a study of the effects of a beach nourishment project in South Carolina. A study by Dolan et al. (1992) of the effects of beachfill activities on mole crabs at the Pea Island National Wildlife Refuge, Dare County, North Carolina, indicates that while nourishment has a dramatic effect on mole crabs in the area where beachfill is placed, mole crabs returned to the beach areas that were nourished soon after pumping stopped.

While beach placement and/or nourishment may produce negative effects on intertidal macrofauna, they would be localized in the vicinity of the nourishment operation. Beach nourishment conducted as a component of the proposed action would be expected to move along the beach at a relatively slow rate (i.e., about a mile per month or about 200 ft. per day). Such a rate of progress is slow enough that surf-feeding fishes and shorebirds can move to other areas that are not affected by the nourishment operation. As the dredging operation passes by a section of beach, that area is soon available for recolonization by invertebrates.

In a 1999 Environmental Report on the use of federal offshore sand resources for beach and coastal restoration, the U.S. Department of Interior, Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) (formerly known as the Minerals Management Service (MMS), provided the following assessment of potential effects on beach fauna from beach nourishment.

> *Because benthic organisms living in beach habitats are adapted to living in high energy environments, they are able to quickly recover to original levels following beach nourishment events; sometimes in as little as three months (Van Dolah et al. 1994; Levisen and Van Dolah, 1996). This is again attributed to the fact that intertidal organisms are living in high energy habitats where disturbances are more common. Because of a lower diversity of species compared to other intertidal and shallow subtidal habitats (Hackney et al. 1996), the vast majority of beach habitats are re-colonized by the same species that existed before nourishment (Van Dolah et al. 1992; Nelson 1985; Levisen and Van Dolah 1996; Hackney et al. 1996).*

As a component of their review of the potential effects of beach nourishment on surf zone fishes and invertebrates in the South Atlantic Bight, Hackney et al. (1996) identified nine fish species and five invertebrate species/groups that are important inhabitants of the intertidal and subtidal beach environment. According to their literature review of associated impacts to these species and how best to protect the natural resources associated with beach nourishment, they identified four management questions to address for each nourishment project: (1) project timing, (2) sediment

compatibility, (3) nourishment duration, and (4) innovative ways to minimize effects (i.e., staging nourishment events). Those questions were considered during planning efforts associated with the proposed dredging and beach disposal efforts for this project.
In 2004, the USACE completed the a study that assessed the impacts of Beach Nourishment on Nearshore and Surf Zone Fish and Benthic Resources on Bald Head Island, Caswell Beach, Oak Island, and Holden Beach, North Carolina (USACE 2004). This study states: "Based on fish sampling with seines and trawls, no immediate impacts in fish abundances and diversities among the disturbed, undisturbed, and reference stations were found at any beach (i.e., Bald Head Island, Caswell Beach, Oak Island, and Holden Beach)." These results were further supported by the second year study where annual and quarterly seine and trawl sampling exhibited no significant depressions in abundance and diversity one-year after the initial beach construction. The schooling nature of a number of dominant species and the highly mobile nature of the fish community constrained the ability to detect impacts and recovery. The fish community's ability to migrate caused a highly variable community in both a temporal and spatial aspect but also indicated that they could move in and out of the beaches impacted by the replenishment operations. Copies of this monitoring reports were provided to the Federal and State review agencies (including NMFS and NCDMF). Additionally, the proposed DMMP interval for beach placement on Bogue Banks is on average every third year. This means that the frequency of beach placement provides a two-to-three-year period when sediment is not placed on the beach. Moreover, dredging and placement would be accomplished within the previously-described dredging windows thus avoiding the peak recruitment periods for surf zone fish (March through September [Hackney et al. 1996]) and invertebrate species (May through September [Hackney et al. 1996; Diaz 1980; Reilly and Bellis 1978]) in North Carolina. This means that any beach placement is likely to be completed before the onshore recruitment of most surf zone fishes and invertebrate species.

Placement of dredged material that is similar to native sediment minimizes impacts to benthic invertebrates. During each disposal interval, any loss of intertidal organisms would be temporary, as repopulation would be expected to begin as soon as the placement operation ends with recolonization of the beach by organisms from adjacent unaffected areas and offshore.

In summary, temporary effects on intertidal macrofauna in the immediate vicinity of the beach placement activity would be expected as a result of discharges of dredged material on the beach. While the proposed beach placement may adversely affect intertidal macrofauna, with the implementation of environmental measures discussed above (i.e., project timing, sediment compatibility/similarity, disposal duration, and placement location), such effects would be expected to be localized and short-term. Any reduction in the numbers or biomass (or both) of intertidal macrofauna present immediately after beach placement may have localized limiting effects on surf-feeding fishes and shorebirds because of a reduced food supply. In such instances, those animals may be temporarily displaced to other locations.

No Action Alternative. Dredging and the disposal activities within the upland Brandt Island and the offshore ODMDS will not result in any adverse impacts to intertidal macrofauna.

The No Action alternative impacts to the intertidal macrofauna on the beaches of Bogue Banks and in the surf zone would be the same as mentioned for the proposed DMMP.

For the No Action alternative, the proposed beach placement may adversely impact intertidal macrofauna; however, these effects will be localized and short-term.

5.5.3 Benthic Resources - Nearshore Ocean and Beaufort Inlet Ebb Tide Delta

Proposed DMMP. Dredging and disposal activities within Brandt Island or the Beaufort Inlet ebb tide delta would not result in any adverse impacts to benthic resources in the nearshore ocean or ebb tide delta. Additionally, the effluent being discharged from the Brandt Island upland diked disposal site into the Inner Harbor will not adversely impact biota.

Benthic organisms within the defined federal navigation channels, ebb tide delta, and the nearshore placement areas off Bogue and Shackleford Banks would be lost. However, these channels have been maintained for many years and impacts of dredging have been addressed in previous NEPA documents (refer to Section 1.5, Incorporation by Reference) . Construction of Morehead City Harbor was authorized in 1910 and over the years the channels have been widened and deepened to their present width and depth.

The proposed base plan would use the Nearshore Placement areas off Bogue and Shackleford Banks in years 2 and 3 of the 3-year maintenance cycle. The proposed expanded nearshore placement area off Bogue Banks is a total of 1,768 acres (i.e., existing and expanded 559 and 1,209 acres, respectively). The proposed nearshore area off Shackleford Banks is about 1,094 acres. Under no circumstance would the entire 2,303 acres of nearshore placement areas be impacted during one maintenance cycle. Different portions of the nearshore placement areas would be used during each maintenance cycle so the same areas within the ebb tide delta would not be disturbed year after year, thus allowing recovery time for the benthos. There would also be a full year recovery period in year 1 of the 3-year cycle when placement in the Nearshore Areas would not occur. Moreover, the location of the nearshore areas is within the ebb tide delta, which is a dynamic high energy environment with swift currents and large waves. Placement of dredged material within the Beaufort Inlet ebb tide delta is needed to ameliorate ebb tide delta deflation. The 3-year cycle and the proposed placement methodology would minimize impacts to the benthic habitat within the Nearshore Placement areas.

Disturbance and impacts on the benthic habitat by either placement of sediment or by removing sediment (i.e., maintenance of the existing federal navigation channels) is similar. Benthic organisms would be lost by either placement activities (smothering) and/or by maintaining the federal navigation channels (removal) from the substrate. Additionally, both disposal and maintenance dredging activities would provide new benthic habitat to recolonize over time. However, it can be presumed that the maintenance of existing navigation channels and placement of sediment in the nearshore areas as described in the proposed DMMP would have similar benthic recovery rates. The reasons being that the existing benthic communities are removed by the proposed dredging action and there are adjacent undisturbed areas that provide benthic populations for recolonization.

The nearshore placement areas are within the Beaufort Inlet Ebb Tide Delta off Bogue and Shackleford Banks and recolonization by opportunistic species would be expected to begin soon after the dredging and placement activity stops. Because of the opportunistic nature of the species that inhabit the soft-bottom benthic habitats, recovery would be expected to occur within 1–2 years. Rapid recovery would be expected from recolonization from the migration of benthic organisms from adjacent undisturbed areas and by larval transport. Monitoring studies of post-dredging effects and recovery rates of borrow areas indicates that most borrow areas usually show significant recovery by benthic organisms approximately 1 to 2 years after dredging (Naqvi and Pullen 1982; Bowen and Marsh, 1988; Johnson and Nelson 1985; Saloman et al. 1982; Van Dolah et al. 1984; and Van Dolah et al. 1992). According to Posey and Alphin (2000), benthic fauna associated with sediment removal from borrow areas off of Carolina Beach recovered quickly with greater inter-annual variability than differences from the effects of direct sediment removal. However, a potential change in species composition, population, and community structure may occur from the initial sediment removal impact and the change in surficial sediment characteristics, resulting in the potential for longer recovery times (2–3 years) (Johnson and Nelson, 1985; Van Dolah et al. 1984). Differences in community structure may occur that may last 2–3 years after initial density and diversity levels recover (Wilber and Stern 1992). Specifically, large, deeper-burrowing infauna can require as long as 3 years to reach pre-disturbance abundance. According to Turbeville and Marsh (1982), long-term effects of a borrow site at Hillsboro Beach, Florida, indicated that species diversity was higher at the borrow site than at the control site.

According to Cahoon et al. (1990 and 1992), primary production in Onslow Bay is characterized as being dominated by benthic microalgae, rather than phytoplankton. Therefore, Onslow Bay food web interactions with demersal zooplankton grazers are significant. The nearshore placement areas within the ebb tide delta are located in depths not exceeding 40-feet and average about 25 feet NGVD. According to Dr. Cahoon (Larry Cahoon, personal communication, June 7, 2011), although a direct short-term dredging impact would occur by placing sediment within the nearshore areas benthic microalgae are very adaptable to disturbance and the effects of the dredging would likely be no more significant than large storm events. The chlorophyll *a* concentrations decrease as depth increases; however, solar irradiance at 40 ft. or less is not a limiting factor, and recruitment of benthic microalgae at the proposed post-placement depths (maximum of ~40 ft and average depth of 25 feet NVGD) would be expected to occur fairly quickly (about 4–6 weeks). Furthermore, dredging with nearshore placement occurs primarily in the winter months when microalgae biomass is low. Therefore, impacts would occur during periods of low biomass, prior to the start of spring time recruitment (Larry Cahoon, personal communication, June 7, 2011).

As identified in Section 5.5.6, placement of sediment in the ebb tide delta (nearshore placement areas) would not be expected to have an adverse physical effect on any hard bottom in the area. Surveys have indicated that no hard bottoms are located in or adjacent to the nearshore placement areas off Bogue and Shackleford Banks (USACE 2009).

Effects on estuarine-dependent organisms are not expected to be significant because placement activities in the ebb tide delta, and proposed disposal on beaches would be localized and would not occur in the same location in consecutive years. A study of nearshore borrow areas after dredging offshore of South Carolina revealed no long-term effects on fishery and planktonic organisms, as a result of the dredging (Van Dolah et al. 1992). In a 1999 Environmental Report on the use of federal offshore sand resources for beach and coastal restoration, the MMS provided the following assessment of potential turbidity impacts.

> *The impacts from turbidity on benthic organisms during dredging operations were reviewed in detail by Pequegnat et al. (1978) and Stern and Stickle (1978). Both studies concluded that impacts to the benthic populations of the marine ecosystem from turbidity are local and temporary but not permanent. Similarly, recent studies show that benthic impacts may be limited to the immediate vicinity of dredging operations (e.g., Hitchcock et al. 1998; MMS 1996).*

According to Deaton et al (2010): *On ebb tide deltas, spionid and oweniid polychaetes, haustoriid and phoxocephalid amphipods, venus clams, tellin clams, and lucina clams are the dominant infauna (Bishop et al. 2006), while decapod crustaceans and echinoderms (sand dollars) are abundant epifauna. Given that periodic storms can affect benthic communities along the Atlantic coast to a depth of about 115 ft (35 m), the soft bottom community tends to be dominated by opportunistic taxa that are adapted to recover relatively quickly from disturbance (Posey and Alphin 2001; Posey and Alphin 2002).*

Implementation of the DMMP would not result in long-term adverse impacts to benthic resources in the ebb tide delta or the nearshore ocean.

No Action Alternative. Dredging and the disposal activities within the existing Brandt Island upland diked disposal site will not result in any adverse impacts to benthic resources.

Disposal of dredged material on the Bogue Banks beaches, the Nearshore West and the ODMDS areas may affect benthos. Covering of benthos and benthic habitat by discharged sediment represents a temporary resource loss since the discharge site will become a new area of benthic habitat and will be recolonized by benthic organisms.

The ecological significance of temporary benthic losses is considered minor since the affected area is very small relative to the amount of benthic habitat present on the ocean bottom, the time span of loss is likely a period of months, and benthic populations in the vicinity are in a state of flux due to the dynamic sediment conditions in the area.

The proposed DMMP implementation will result in continued use of the EPA designated Morehead City ODMDS in accordance with the Morehead City ODMDS Site Monitoring and Management Plan. Only dredged material evaluated and found acceptable in accordance with the joint USEPA/USACE guidance (USAEPA/USACE 1991 and USEPA/USACE 1993) may be disposed of in the ODMDS.

5.5.4 Surf Zone Fishes

Proposed DMMP. The surf zone is a dynamic environment, and the community structure of organisms that inhabit it (e.g., surf zone fishes and invertebrates) is complex. Representative organisms of both finfish and the invertebrate inhabitants they consume exhibit similar recruitment periods. In North Carolina, the majority of invertebrate species recruit between May and September (Hackney et al. 1996; Diaz, 1980; Reilly and Bellis, 1978), and surf zone fish species recruit from March through September (Hackney et al. 1996). Adherence to the previously described dredging and disposal windows would avoid the peak recruitment and abundance periods for most surf zone fishes and their benthic invertebrate prey source.

The surf zone represents HAPC for some species, including adult bluefish and red drum, which feed extensively in that portion of the ocean. The surf zone is suggested to be an important migratory area for larval/juvenile fish moving in and out of inlets and estuarine nurseries (Hackney et al. 1996). Placement operations along the beach can result in increased turbidity and mortality of intertidal macrofauna, which serves as food sources for those and other species. Therefore, feeding activities of the species could be interrupted in the immediate area of sand placement. Those mobile species are expected to temporarily relocate to other areas as the project proceeds along the beach. However, some species like Florida pompano and Gulf kingfish exhibit strong site fidelity during the middle portion (summer) of the nursery period (Ross and Lancaster 2002) and might not avoid secondary effects (turbidity) of disposal. Because the project would avoid impacts to the surf zone during the summer months, it is expected that the project would not affect this period of strong site fidelity. Although a short-term reduction in prey availability could occur in the immediate disposal area, only a small area is affected at a time, and once complete, organisms can recruit into the nourished area. Such a recovery would begin immediately after disposal activity if the material is similar to the native beach (see Benthic Resources—Beach and Surf Zone Section 5.5. 2).

According to Ross and Lancaster (1996) some surf zone fishes exhibit prey switching in relation to prey availability. Therefore, during periods of low prey availability, as a result of short-term impacts to the benthic invertebrate population during beach placement activities, surf zone fishes may temporarily use alternative food sources. Considering the dynamic nature of the surf zone, such opportunistic behavior of avoidance and prey switching might enable some surf zone fishes to adapt to disturbances such as beach nourishment. A combination of short-term prey switching and temporary relocation capabilities may help mitigate short-term prey reductions during beach placement operations. Once the placement operation is finished, physical conditions in the impact zone quickly recover and biological recovery soon follows. Surf-feeding fish can then resume their normal activities in the areas. That is supported in Ross and Lancaster's (2002) study in which Florida pompano and Gulf kingfish appeared to remain as long near a recently nourished beach as a beach that was not recently nourished.

Placement and subsequent turbidity increases may have short-term effects on surf zone fishes and prey availability. However, the opportunistic behavior of the organisms within the dynamic surf zone environment enables them to adapt to short-term disturbances. Because of the adaptive ability of representative organisms in the area and avoiding peak recruitment and abundance time frames by adhering to the dredging and placement windows, such effects would be expected to be temporary and minor.

No Action Alternative. Dredging and the disposal activities within the upland Brandt Island will not result in any adverse impacts to surf zone fishes. Placement of dredged material on the Bogue Banks beaches, the Nearshore West and the ODMDS areas may affect surf zone fishes and their feeding habitat. However, the surf zone is a dynamic environment, and the community structure of organisms that inhabit it (e.g., surf zone fishes and invertebrates) is complex. Representative organisms of both finfish and the invertebrate inhabitants they consume exhibit similar recruitment periods. In North Carolina, the majority of invertebrate species recruit between May and September (Hackney et al. 1996; Diaz 1980; Reilly and Bellis 1978), and surf zone fish species recruit from March through September (Hackney et al. 1996). The construction time frames for the No Action alternative is from January 1 to March 31 if a hopper dredge is used and November 16 to April 30 if a pipeline dredge is used. These construction windows would avoid a majority of the peak recruitment and abundance periods of surf zone fishes and their benthic invertebrate prey source.

The existing No Action alternative will continue to use the EPA designated Morehead City ODMDS in accordance with the Morehead City ODMDS Site Monitoring and Management Plan. Only dredged material evaluated and found acceptable in accordance with the joint USEPA/USACE guidance (USAEPA/USACE 1991 and USEPA/USACE 1993) may be disposed of in the ODMDS.

5.5.5 Beaufort Inlet Ebb Tide Delta Fish, Crabs, and Shrimp

Within the Beaufort Inlet ebb tide delta, various fish (i.e., snapper - grouper species complex) , crabs, and penaeid shrimp use the delta for foraging, predator avoidance, and staging before moving into the estuary. The Beaufort Inlet ebb tide delta is designated as a Habitat Area of Particular Concern because the delta is part of Beaufort Inlet.

Proposed DMMP. The proposed DMMP will impact the Beaufort Inlet ebb tide delta since both the existing/expanded 1,768 acre nearshore area off Bogue Banks and the proposed 1,094 acre nearshore area off Shackleford Banks is located within the delta.

The Beaufort Inlet ebb tide delta is an important feeding ground for numerous fish that forage on benthic invertebrates (Deaton et al, 2010). Many of these same species congregate in and around these features during various times of the year to enhance prey acquisition or reproduction (Deaton et al, 2010).

The ebb tide delta also provides refuge to small and juvenile fishes, as well as invertebrates. According to Deaton et al (2010): *Many fish and invertebrates, including hard clams, flatfish, skates, rays, and other small cryptic fish, like gobies, avoid predation by burrowing partially or completely into the sediment, thus camouflaging themselves from predators.* Numerous migrating juvenile and subadult demersal fishes use the ebb tide delta as corridors from the ocean to estuary. Anadromous fish including sturgeon and striped bass also use Beaufort Inlet and its adjacent ebb tide delta as a corridor to reach upstream spawning areas.

Both nearshore placement areas off Bogue and Shackleford Banks are located within the littoral zone and within the ebb tide delta. As indicated in Section 3.2.4, significant deflation of the ebb tide delta has occurred during our study period of 1974 to 2009. Reviewing these surveys indicates that extensive erosion occurred over a majority of both the east and west halves of the inlet ebb tide delta with the erosion in the west side (Bogue Banks) of the delta ranging from 3 to 7 feet, while the erosion on the east side (Shackleford Banks) of the navigation channel ranged from 6 to 12 feet. Any sediment placed in these nearshore areas would reduce or minimize any future deflation of the Beaufort Inlet Ebb Tide Delta (discussed in Section 3.2.4 Ebb Tide Delta). As stated in Section 5.5.3, under no circumstance would the entire 2,303 acres of nearshore placement areas off Bogue and Shackleford Banks be impacted during one maintenance cycle. Different portions of the nearshore placement areas would be used during each maintenance cycle so the same areas within the ebb tide delta would not be disturbed in year after year, thus allowing recovery time for the benthos, as well as fish, crabs, and shrimp. There would also be a full year recovery period in year 1 of the 3-year cycle when placement in the nearshore areas would not occur.

Additionally, the DMMP proposes that only coarse-grained sediment (90% or greater sand) be placed in the nearshore areas off Bogue and Shackleford Banks predominately during the winter months (i.e., January 1 to March 31). The USACE does not anticipate any significant increase in turbidity levels within Beaufort Inlet ebb tide delta complex since only coarse-grained sediment (90% or greater sand) will be placed on the beaches and within the nearshore areas. The most dynamic habitats in the project area are within the beach surf zone and Beaufort Inlet ebb tide delta . Once the disposal operation has passed, physical conditions in the impact zone quickly recover and biological recovery soon follows. Therefore the USACE does not anticipate any significant impacts on fish, crabs, and shrimps in the Beaufort Inlet ebb tide delta complex.

No Action Alternative. The existing 559 acre nearshore placement area off Bogue Banks is located within the Beaufort Inlet ebb tide delta. The No Action Alternative has placed sediment within this nearshore area since the mid-1990's. Only coarse-grained sediment (90% or greater sand) has been placed in the nearshore areas off Bogue Banks. No significant increase in turbidity levels has been observed as a result of placing this coarse-grained sediment in the nearshore area. No adverse impacts to fish, crabs, or shrimp has occurred as a result of this activity.

5.5.6 Larval Entrainment

Proposed DMMP. For many marine fishes, spawning grounds are believed to occur on the continental shelf with immigration to estuaries during the juvenile stage through active or passive transport. According to Hettler and Hare (1998), research suggests two bottlenecks that occur for offshore-spawning fishes with estuarine juveniles: the transport of larvae into the nearshore zone and the transport of larvae into the estuary from the nearshore zone. During that immigration period from offshore to inshore environments, the highest concentration of larvae generally occurs in the inlets as the larvae approach the second bottleneck into the estuary. Once through the inlet, the shelter provided by the marsh and creek systems in the sound serve as nursery habitat where young fish undergo rapid growth before returning to the offshore environment.

Those free floating planktonic larvae lack efficient swimming abilities and are, therefore, susceptible to entrainment by an operating hydraulic or hopper dredge as they immigrate from offshore to inshore waters. The majority of the Morehead City Harbor navigation channels are located within or adjacent to Beaufort Inlet. Maintenance dredging of these federal navigation channels would occur in the highest concentration *inlet bottleneck* areas.

Susceptibility to this effect of entrainment is largely dependent on proximity to the cutter-head or drag-head and the pumping rate of the dredge. Those larvae present near the bottom would be closer to the dredge area and would, therefore, be subject to higher risk of entrainment. Assessment of the significance of the entrainment is difficult. Assuming the very small volumes of water pumped by dredges relative to the total amount of water in the dredging vicinity, a small proportion of organisms are presumed to be affected. Potential reasons for low levels of impact include the extremely large numbers of larvae produced by most estuarine-dependent species and the extremely high natural mortality rate for early life stages of many fish species. Because natural larval mortalities might approach 99 % (Dew and Hecht 1994; Cushing 1988), entrainment by a hydraulic dredge would not be expected to pose a significant additional risk in most circumstances.

An assessment of potential entrainment effects of the proposed dredging action may be viewed in a more site-specific context by comparing the pumping rate of a dredge with the amount of water present in the affected waterbody (Appendix I). For the purposes of this assessment, assumptions would be made that inlet bottlenecks would have the highest concentrations of larvae as they are transported into the estuarine environment from the nearshore zone. Larval effects of dredging in this *high-concentration* system would be significantly greater than the entrainment risk of dredging in offshore channels. The larval fish distributions, abundance seasonality, transport, and ingress at Beaufort Inlet, North Carolina, has been extensively studied (Blanton et al. 1999; Churchill et al. 1999; Hettler and Barker 1993; Hettler and Chester 1990; Hettler and Hare 1998).

Therefore, it represents a good case study site for assessing larval entrainment of a hydraulic dredge. The largest hydraulic dredge likely to work in offshore borrow areas would have a discharge pipe about 30 inches in diameter and would be capable of transporting about 30,600 m^3 of sand per day if operated 24 hours (because of breakdown, weather, and the like, dredges generally do not work 24 hours a day, 7 days a week). The dredged sediment would be pumped as slurry containing about 15 % sand and about 85 % water by volume. The volume of water discharged would, thus, be about 173,000 m^3 per day, or about 2.0 m^3 per second. In contrast, the calculated spring tide flow through Beaufort Inlet (a representative North Carolina inlet) is approximately 142,000,000 $m^3 \times 2$ = 284,000,000 m^3 (i.e., two tides a day) of water and 264,000,000 m^3 during neap tide. Thus, the dredge would entrain only 0.06 to 0.07 % of the daily volume flux through the inlet. According to Larry Settle (2002), the percentage of the daily flux of larvae entrained during a spring and neap tide is very low regardless of larval concentration and the distribution of larvae within the channel. Under the worst-case scenario with the highest concentrations of larvae possible based on spatial and temporal distribution patterns, the maximum percentage entrained barely exceeds 0.1 % per day. See Appendix I for a complete detailed analysis. Although any larvae entrained (calculations indicate 914 to 1.8 million depending on the initial concentration in the tidal prism) would likely be killed, the effect at the population level would be expected to be insignificant. On the basis of those calculations indicating an *insignificant* larval entrainment impact, at the population level, from hydraulic dredging activities within a representative high concentration *inlet bottleneck* at Beaufort Inlet, North Carolina, the proposed DMMP would not be expected to adversely affect overall marine fish larvae populations.

No Action Alternative. The No Action alternative would use the same dredge plants and current windows for maintaining the existing federal navigation channels. The purpose of these dredges (i.e., hopper, pipeline, and bucket and barge) is to remove sediment shoals from the bottom and sides of the existing channels not to pump water from the water column. Larvae and early juvenile stages of many species pose a greater concern that adults because their powers of mobility are either absent or poorly developed, leaving them subject to transport by tides and currents. This physical limitation makes them potentially more susceptible to entrainment by an operating pipeline and/or hopper dredges. Organisms close to the pipeline cutterhead or the hopper dredge draghead may be captured by the effects of its suction and may be entrained in the flow of dredged sediment and water. As a worst-case, it is assumed that entrained animals experience 100 % mortality, although some small number may survive. Due to the large numbers of larval organisms (Appendix I), it is not expected that entrainment mortality would adversely affect species population levels. No adverse impacts are anticipated.

5.5.7 Hardbottoms

Proposed DMMP. Review of data provided by the Southeast Monitoring and Assessment Program (SEAMAP 2001) identified two potential areas of hard bottom one off Pine Knoll Shores, about 2 miles south of the project area and the other off Shackleford Banks, over 2,000 feet off the proposed disposal area (Figure 5-1).

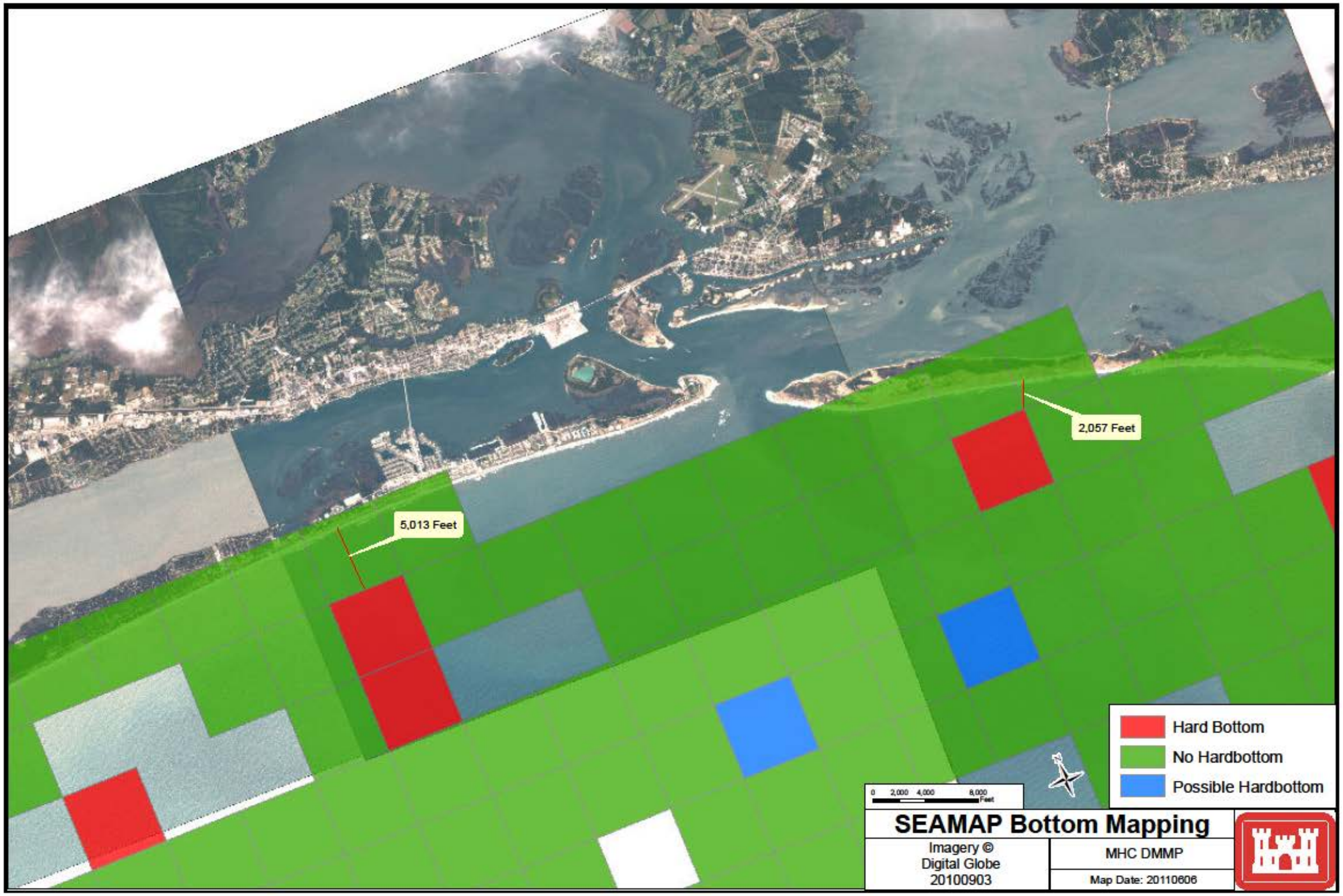


Figure 5-1. Distribution of Potential Bottom Habitats on the Continental Shelf from NC to the Florida Keys (SEAMAP 2001).

Dr. Eleanor J. Camann (2005) indicated that nearshore surveys were conducted along Shackleford Banks using sidescan sonar, swath bathymetry, and Compressed High Intensity Radar Pulse (CHIRP) on November 18, 2003 courtesy of Dr. Jesse McNinch, his equipment, and a Virginia Institute of Marine Science (VIMS) research vessel and crew. The results of these surveys did not find any hardbottom areas offshore off Shackleford Banks (Camann 2005). Discussions with Dr. McNinch (Jesse McNinch, personal communication, 7 June 2011) indicate that the nearshore surveys most likely depicted relict channels where former tidal inlets on the island existed and not hardbottom areas.

To assess potential beach nourishment impacts from the BBHSDR Project to hardbottom resources in the nearshore environment off of Bogue Banks, North Carolina, the U.S. Army Corps of Engineers initiated ground-truthing investigations of potential hardbottom habitat within and adjacent to the project area (USACE 2010a). The study area was located in the nearshore environment off Bogue Banks, North Carolina, between Bogue Inlet and Beaufort Inlet. Previously conducted sidescan sonar surveys of this area and interpretation of that data conducted identified possible seafloor morphology of interest between 250 feet and 2500 feet from shore and between the -5 to -30-foot NGVD water depth contours (Greenhorne and O’Mara 2007). This area is located on and/or within the limits of the calculated -25-foot NVGD depth of closure identified for the BBHSDR and may be impacted as a result of project construction. To assess potential beach nourishment impacts to hardbottom resources, USACE required ground-truth investigations of potential hardbottom within and adjacent to the BBSPP.

Ground-truth verification was completed on January 21 and 22, 2009 (USACE 2009b). Several ground-truthing surveys conducted during the course of this investigation inshore of the depth of closure found only fine sand where sidescan sonar interpretations suggested other seafloor morphologies of interest. The explanation for this discrepancy is that sand movement within the depth of closure along a beach profile is well established and can be proven to have occurred through an examination of historic beach profiles. Although it is logical to assume sand movement inside the depth of closure, which is documented, it is the conclusion of this investigation that no hardbottom resources are present within the area surveyed in 2007 (Greenhorne and O’Mara 2007). This conclusion is based on four primary factors:

(1) A re-analysis and interpretation of sidescan sonar data concluded that no signatures indicative of hardbottom habitats existed in the survey area.

(2) Ground-truthing operations confirmed sidescan sonar interpretation of seafloor morphologies of interest,

(3) No hardbottom was found during ground-truthing operations.

(4) An analysis of historic beach profiles along Bogue Banks (Moffat and Nichol 2008) does not suggest any rock outcrops along beach profiles.

Additional side-scan sonar surveys within the proposed Shackleford Banks nearshore and the proposed expanded Nearshore West Placement Areas revealed no evidence of hard bottoms. (USACE 2010a). This remote-sensing data confirms that proposed material placement at the sites will not have any impact on exposed hard bottoms or associated marine life.

No Action Alternative. The No Action alternative results in the disposal of suitable sediment on the beaches and nearshore area off Bogue Banks. All maintenance dredging will be located within the existing channels of Morehead City Harbor. There are no hardbottoms within these areas. Review of data provided by the Southeast Monitoring and Assessment Program (SEAMAP 2001) identified one area of hardbottom off Pine Knoll Shores, about 2 miles south of the project area. While beach placement will cause turbidity, this effect should be minor and temporary and not affect the hardbottom 2 miles off Pine Knoll Shores. The use of the nearshore placement area or the ODMDS will not adversely affect known hardbottom areas.

5.5.8 Essential Fish Habitat

The Fishery Management Plan Amendments of the South Atlantic Fishery Management Council identify over 30 categories of Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC), which are listed in Table 5-4. While all of these habitat categories occur in waters of the southeastern United States, only a few occur in the immediate project vicinity and/or the project impact zone. Those absent include estuarine scrub/shrub mangroves which require a more tropical environment and several areas that are geographically removed from the project area including: Hoyt Hills located in the Blake Plateau area in water 450-600 meters deep, the Point located off Cape Hatteras near the 200-meter contour, and sandy shoals off Cape Hatteras and Cape Fear. In addition, there are no Council-designated Artificial Reef Special Management Zones, Estuarine Emergent Wetlands, Palustrine Emergent & Forested Wetlands, Intertidal Flats, Oyster Reefs & Shell Banks, Aquatic Beds, Wetlands, Creeks, Seagrass Beds, or Submerged Aquatic Vegetation in the potential project impact area, although some of these habitat types may occur in the vicinity of Morehead City, particularly in and around Bogue Sound. Impacts on habitat categories potentially present in the project vicinity are discussed below.

ESSENTIAL FISH HABITAT	Potential Presence		Potential Impacts	
	In / Near Project Vicinity	Project Impact Area	Dredge Plant Operation	Sediment Disposal Activities
Estuarine Areas				
Estuarine Emergent Wetlands	yes	yes	no	no
Estuarine Scrub / Shrub Mangroves	no	no	no	no
Submerged Aquatic Vegetation (SAV)	yes	yes	no	no
Oyster Reefs & Shell Banks	yes	no	no	no
Intertidal Flats	yes	no	no	no
Palustrine Emergent & Forested Wetlands	no	no	no	no
Aquatic Beds	yes	yes	no	no
Estuarine Water Column	yes	yes	insignificant	insignificant
Seagrass	yes	yes	no	no
Creeks	yes	no	no	no
Mud Bottom	yes	no	no	no
Marine Areas				
Live / Hard Bottoms	nearshore ocean	no	no	no
Coral & Coral Reefs	distant offshore	no	no	no
Artificial / Manmade Reefs	>2 mile away	no	no	no
Sargassum	distant offshore	no	no	no
Water Column	yes	yes	insignificant	insignificant
GEOGRAPHICALLY DEFINED HABITAT AREAS OF PARTICULAR CONCERN				
Area - Wide				
Council-designated Artificial Reef Special Management Zones	no	no	no	no
Hermatypic (reef-forming) Coral Habitat & Reefs	distant offshore	no	no	no
Hard Bottoms	nearshore ocean	no	no	no
Hoyt Hills	distant offshore	no	no	no
Sargassum Habitat	distant offshore	no	no	no
State-designated Areas of Importance of Managed Species (PNAs)	yes	yes	no	no
Submerged Aquatic Vegetation (SAV)	yes	yes	no	no
Coastal Inlets	yes	yes	insignificant	insignificant
North Carolina				
Big Rock	distant offshore	no	no	no
Bogue Sound	yes	yes	insignificant	insignificant
Pamlico Sound at Hatteras / Ocracoke Islands	yes	yes	no	no
Cape Fear sandy shoals	distant offshore	no	no	no
Cape Hatteras sandy shoals	distant offshore	no	no	no
Cape Lookout sandy shoals	distant offshore	no	no	no
New River	yes	yes	no	no
The Ten Fathom Ledge	distant offshore	no	no	no
The Point	distant offshore	no	no	no
Beaufort Inlet Ebb Tide Delta	yes	yes	insignificant	insignificant

Essential Fish Habitat areas are identified in Fishery Management Plan Amendments for the South Atlantic and Mid-Atlantic Fishery Management Councils. Geographically Defined Habitat Areas of Particular Concern are identified in Fishery Management Plan Amendments affecting the South Atlantic Area. Areas listed in this table were derived from Essential Fish Habitat: A Marine Fish Habitat Conservation Mandate for Federal Agencies. February 1999 (Revised 10/2001) (Appendices 4 and 5).

Table 5-4. Categories of EFH and Habitat Areas of Particular Concern in the Project Vicinity and Potential Impacts

Proposed DMMP. Disposal of sediment within the upland Brandt Island will not adversely impact EFH species.

Sediment disposed on the beaches of Bogue Banks, in the Beaufort Inlet Ebb Tide Delta (nearshore placement areas off Bogue and Shackleford Banks), and within the ODMDS may affect EFH. The following information describes these effects:

<u>Impacts on Big Rock and Ten-Fathom Ledge located off Cape Lookout</u>. This site is located about 18 miles east of the project area and would not be affected by the proposed action.

<u>Impacts to New River</u>. The New River is located about 30 miles from the proposed project and would not be affected.

<u>Impacts on Bogue Sound</u>. All work will be located within the existing Morehead City Harbor navigational channels, Brandt Island, and Fort Macon State Park and Atlantic Beach, in the Beaufort Inlet Ebb Tide Delta, and the ODMDS. No dredging or dredged material disposal will occur in Bogue Sound. Therefore the proposed action will not affect Bogue Sound.

<u>Impacts to Beaufort Inlet and the Beaufort Inlet Ebb Tide Delta</u>. The nearshore placement areas off Bogue and Shackleford Banks are located within the Beaufort Inlet Ebb Tide Delta. The Morehead City Harbor navigation channels (Ranges A and B as well as the Cutoff) are within Beaufort Inlet. All Coastal Inlets in North Carolina have been designated as habitat areas of particular concern for penaeid shrimp and snapper grouper species complex. For the penaeid shrimp and snapper grouper species within Beaufort Inlet habitat areas of particular concern include habitats required for each life stage (egg, larval, post larval, juvenile, and adult stages). The USACE completed extensive benthic and sediment sampling for both nearshore areas off Bogue and Shackleford Banks (see Sections 4.1.3 and 4.5.3). The results of the USACE (2010b) report are summarized below:

Sediment Characteristics. Out of the 96 sites sampled, 21.8% of the sites contained 10.3% to 61.0% silt/clay, and 42.7% had a low silt/clay content (<2% silt/clay). Areas of high silt/clay content (>10% and <61.0%) were found with one large group of sites occurring principally offshore of Shackleford Banks and several smaller areas offshore of Bogue Banks, in water depths ranging from ~20 to 49 feet. Areas of low silt/clay content (less than <2% silt/clay content) predominantly were found along the ebb tide delta and along the nearshore of Bogue and Shackleford Banks. A grouping of these stations also occurs offshore in ~40 feet of water. Three large groups of medium silt/clay content (>2 and <10% silt/clay content) occurred in the mid to nearshore of Shackleford Banks, offshore of the ebb tide delta, and in the mid to nearshore of Bogue Banks.

Benthic Community. A total of 7,053 organisms representing 260 taxa were identified from 95 samples. Polychaetes were the most numerous organisms, representing 43.9

percent of the total assemblage, followed by malacostracans (primarily amphipods) at 25.7 %, bivalves (10.5 %) and gastropods (10.0 %). The number of taxa per station ranged from 1 to 57. Station densities ranged from 9.1 organisms/m2 to 4,609 organisms/m2.

Similarity Determinations. Clustering of stations based on sediment and macroinvertebrate species populations and assemblages was evident through spatial analysis. The data suggest that the nearshore site showing the closest correlation and strongest relationships between sample sites is located offshore of Shackleford Banks. This area has medium silt/clay content and benthic species diversity and richness values are moderate to high. The shallow water depths cause the benthic environment to be influenced by scour and sediment resuspension caused by wave action and tidal currents.

As indicated in Table 3-29, the recommended plan for the DMMP proposes that only coarse-grained sediment (90% or greater sand) be placed in the nearshore areas. Additionally, the USACE does not anticipate any significant increase of turbidity levels within either Beaufort Inlet or its ebb tide delta since only coarse-grained sediment (90% or greater sand) will be placed on the beaches and within the nearshore areas. Within the beach surf zone and Beaufort Inlet ebb tide delta are the most dynamic habitats in the project area. Once the disposal operation has passed, physical conditions in the impact zone quickly recover and biological recovery soon follow. Lastly, impacts of dredging the channels within Beaufort Inlet are addressed within the marine water column paragraph below. Therefore the proposed DMMP will not significantly impact penaeid shrimp and snapper grouper species (or their life stage of egg, larval, post larval, juvenile, and adult stages) within Beaufort Inlet or the Beaufort Inlet Ebb Tide Delta.

<u>Impacts on Sargassum</u>. *Sargassum* is pelagic brown alga which occurs in large floating mats on the continental shelf, in the Sargasso Sea, and in the Gulf Stream. It is a major source of productivity in a nutrient-poor part of the ocean. Masses of *Sargassum* provide extremely valuable habitat for a diverse assemblage of animal life, including juvenile sea turtles, sea birds, and over 100 species of fish. Unregulated commercial harvest of *Sargassum* for fertilizer and livestock feed has prompted concerns over the potential loss of this important resource. While smaller clumps of this seaweed may float into the project area, it typically occurs much farther offshore. In any case, since it occurs in the upper few feet of the water column, it is not subject to impacts from dredging or placement activities associated with the proposed action.

<u>Impacts on Reef-forming Corals</u>. Hermatypic, or reef-forming, corals consist of anemone-like polyps occurring in colonies united by calcium encrustations. Reef-forming corals are characterized by the presence of symbiotic, unicellular algae called zooxanthellae, which impart a greenish or brown color. Since these corals derive a very large percentage of their energy from these algae, they require strong sunlight and are, therefore, generally found in depths of less than 150 feet. Corals require warm water temperatures (68° to 82° F) and generally occur between 30˚N and 30˚S latitudes. Off the east coast of the United States, this northern limit roughly coincides with northern Florida. Although corals

occur off the North Carolina coast, they are not known from the immediate project vicinity, and should not be affected by the proposed action.

Impacts on Artificial Reefs. The North Carolina Division of Marine Fisheries (NCDMF) lists six artificial reefs (AR) in the project vicinity. They are AR 315, AR 320, AR 330, AR 340, AR 342, and AR 345 (Figure 4-9, above). Dredging and disposal of material on Bogue Banks beaches or in the nearshore placement areas will not be done in close proximity to any of these artificial reefs, so no adverse impacts would occur. The closest artificial reef (AR 315) is about 2 miles offshore off Atlantic Beach in an average water depth of 49 feet. Turbidity plumes may be produced by disposal of the dredged material on the beaches of Bogue Banks or in the nearshore areas as fine sediments are washed away by littoral processes. If such plumes are still detectable as far offshore as the NC Artificial Reef Project (NCARP) reefs, the effects should be minor, temporary, and should quickly dissipate. The proposed action will not significantly impact any NCARP reefs.

Impacts on Hard bottoms. All maintenance dredging will be located within the existing channels of Morehead City Harbor. There are no hard bottoms within these areas. Review of data provided by the Southeast Monitoring and Assessment Program (SEAMAP 2001) identified one area of hard bottom off Pine Knoll Shores, about 2 miles south of the project area. While beach placement will cause turbidity, this effect should be minor and temporary and not affect the hard bottom 2 miles off Pine Knoll Shores. On 24 August 2009, a contract was awarded to survey the nearshore areas off Bogue and Shackleford Banks for hard bottoms. The results of this survey indicate that no hard bottoms are found within the sediment placement areas in the nearshore areas off Bogue (USACE 2009b) and Shackleford Banks (USACE 2010a). This remote-sensing data confirms that proposed dredged material placement at the sites would not have any impact on exposed hard bottoms or associated marine life. Lastly, the use of the ODMDS will not adversely affect known hard bottom areas.

Impacts on State-designated Areas Important for Managed Species. Primary Nursery Areas (PNAs) are designated by the NC Marine Fisheries Commission and are defined by the State of North Carolina as tidal saltwater, which provide essential habitat for the early development of commercially important fish and shellfish (15 NC Administrative Code 3B .1405). Many fish species undergo initial post-larval development in these areas. This project will not impact PNAs because they are not present in the project impact area.

Impacts on the Marine Water Column. The potential water quality impacts of dredging and disposal are addressed in the following sentences. Dredging and disposal operations conducted during project construction may create impacts in the marine water column in the immediate vicinity of the activity potentially affecting the nearshore ocean area. These impacts may include minor and short-term suspended sediment plumes and related turbidity, as well as the release of soluble trace constituents from the sediment. During dredging, turbidity increases outside the dredging area should be less than 25 NTUs and are, therefore, considered insignificant. Overall water quality impacts of the proposed action are expected to be short-term and minor. Living marine resources dependent upon good water quality are not expected to experience significant adverse impacts due to water quality changes.

Scientific data are very limited with regard to the effects of placement of dredged material on Bogue Banks on fishery resources. These effects may be similar, on a smaller scale, to the effects of storms; storm effects may include increased turbidity and sediment load in the water column and, in some cases, changes in fish community structure (Hackney et al. 1996).

Placement of dredged material on the beaches of Bogue Banks may affect fishery resources and EFH through increases in turbidity and sedimentation that, in turn, may create localized stressful habitat conditions and may result in temporary displacement of fish and other biota. However, less than 200 feet of beach per day would be impacted, and mobile biota, including juvenile and adult fish, should be able to relocate outside the more stressful conditions of the beach placement area.

<u>Impacts on Cape Lookout Sandy Shoals</u>. The sandy shoals off Cape Lookout are located over 10 miles southeast of the entrance to Morehead City Harbor. No effects on these shoals are anticipated.

<u>Impacts on Mud Bottoms</u>. Mud bottoms would not be affected by this action.

<u>Impacts of Larval Entrainment</u>. Larvae and early juvenile stages of many species pose a greater concern than adults because their powers of mobility are either absent or poorly developed, leaving them subject to transport by tides and currents. This physical limitation makes them potentially more susceptible to entrainment by an operating pipeline and/or hopper dredges. Organisms close to the pipeline cutterhead or the hopper dredge draghead may be captured by the effects of its suction and may be entrained in the flow of dredged sediment and water. The intake of the dredge is principally below the sediment surface. As a worst-case, it may be assumed that entrained animals experience 100 % mortality, although some small number may survive. Due to the large numbers of larval organisms, it is not expected that entrainment mortality would adversely affect species population levels.

<u>Impacts on other Habitat Areas of Particular Concern (HAPC)</u>. Tidal inlets comprise HAPC for several important species, including the planktonic larvae of brown shrimp, white shrimp, pink shrimp, as well as the eggs and larvae of red drum. These species are sometimes present in Beaufort Inlet, which is the location of the entrance channel to Morehead City Harbor. Therefore, channel dredging would likely impact the early life stages of these species through entrainment by suction dredging. While individual mortality is the result, population level impacts are considered to be insignificant.

The surf zone represents HAPC for adult bluefish and red drum that feed extensively in this portion of the ocean. Disposal operations along the beach can result in increased turbidity and mortality of intertidal macrofauna that serve as food organisms for these and other species. Therefore, feeding activities of these species may be interrupted in the immediate area of beach placement. However, these mobile species are expected to temporarily relocate to other areas as the work proceeds along the beach. Once the placement operation has passed, physical conditions in the impact zone quickly recover and biological recovery soon follow. Surf-feeding fish can then resume their normal activities in these areas. Therefore, these impacts are considered temporary and minor.

Impact Summary for Essential Fish Habitat. The proposed action is not expected to cause any significant adverse impacts to Essential Fish Habitat or EFH species. Impacts are expected to be minor on an individual and cumulative effects basis. Therefore, mitigation is not required.

No Action Alternative. Sediment would be disposed in Brandt Island, on the beaches of Bogue Banks, the existing and expanded Nearshore West, and within the ODMDS.

EFH for the No Action plan has already been assessed and approved by NMFS. The EA/FONSI dated 2009 for the Interim Operations Plan (USACE 2009a) stated that the No Action plan would not adversely impact EFH. NMFS has concurred with this determination.

Impact Summary for Essential Fish Habitat. The No Action plan would not be expected to cause any significant adverse impacts to Essential Fish Habitat or EFH species. Impacts would be minor on an individual and cumulative effects basis. Therefore, mitigation is not required.

5.6 Wetlands and Floodplains

Proposed DMMP. No Section 404 jurisdictional wetlands will be filled by the proposed plan on the upland confined diked facility on Brandt Island, Bogue Banks beaches, West and East Nearshore Placement areas, or the ODMDS. Therefore, no adverse impacts are anticipated for Section 404 jurisdictional wetlands.

Dredged material would be disposed in the floodplain adjacent to the Bogue Banks beaches. Beach placement on Bogue Banks would result in an alteration of the floodplain in that the zone of tidal flooding would be displaced seaward. The proposed action is not anticipated to induce development of the floodplain, or to otherwise adversely affect any floodplain, since the existing oceanfront property on Bogue Banks is already developed.

No Action Alternative . No wetlands are known to have been impacted by the maintenance of the Morehead City Harbor navigation channels. Impacts to floodplains are temporary and insignificant.

5.7 Terrestrial Resources

For a number of years, the USACE has placed Harbor sediment on Fort Macon State Park and Atlantic Beach (including Pine Knoll Shores). In many years because of erosion at the Fort Macon State Park, the high tide has reached the base of the frontal dune. The bath house walkway area in the Park usually does not have a “dry” beach at high tide. In some years, the high tide even undermines the wooden walkway from the bath house to the beach. The USACE and its contractor have always made it a point to work with representatives of the State Park and the Towns to ensure that the frontal dunes are not impacted as a result of these beach placement activities. In over 30 years, the contractor’s personnel and equipment have never adversely impacted the frontal dunes on Bogue Banks.

The proposed DMMP will not adversely impact and/or undermine any frontal dunes on Bogue Banks. Equipment will only be allowed waterward of the base of the frontal dune. No equipment will be authorized to temporarily cross or impact any frontal dune within the project area.

5.7.1 Vegetation

Proposed DMMP. Disposal in Brandt Island will cover any existing volunteer species that revegetate the interior of the dike between disposal events. The proposed DMMP is not anticipated to adversely impact any other vegetation in the study area since no vegetation is found within the sand placement area on the ocean beaches of Bogue Banks, nearshore areas off Bogue and Shackleford Banks, or the Morehead City ODMDS. Additionally, at this time there are no plans to expand or raise the Brandt Island dike.

No Action Alternative. Implementation of the No Action alternative would not adversely impact any vegetation since no vegetation is found within any designated disposal or placement sites (i.e., Brandt Island, beaches and nearshore area off Bogue Banks, or the ODMDS).

5.7.2 Wildlife

Proposed DMMP. The proposed DMMP is not expected to adversely impact terrestrial resources found on Brandt Island and along the beach or the dune areas of Bogue Banks. Bull-dozers may be used to place the dredge pipe within Brandt Island but no significant amount of vegetation would be removed.

There are no plans at this time to modify the Brandt Island upland diked disposal area therefore terrestrial resources will not be adversely impacted. No vegetation or habitats on Brandt Island would be removed and/or adversely impacted. As previously stated, should modifications to Brandt Island be deemed feasible in the future, an EA will be prepared and all appropriate environmental clearances will be obtained.

Migratory birds may also use Brandt Island for foraging, nesting, and roosting habitat within the migratory bird nesting season from April 1 to August 31 of any year. However, the NC Wildlife Resources Commission indicates that they consider Brandt Island as low quality migratory bird habitat for the following reasons:

1. Brandt Island is not isolated from Bogue Banks. A small and shallow 25-foot wide tidal creek (Fishing Creek) separates Brandt Island from Bogue Banks. Raccoons and other predators (i.e., cats, dogs, etc.) can reach the island and destroy nests.

2. The NC Wildlife Resources Commission indicates that island heights above 10 feet expose birds and their nests to higher winds and sand movement. The top of the existing dike on Brandt Island is about 40-feet in elevation. Moreover, Brandt Island is heavily vegetated with only a small amount of sandy areas.

If any work is initiated on Brandt Island within the migratory bird nesting season (April 1 to August 31), USACE would coordinate with representatives from the NC Wildlife Resources Commission to ensure that migratory bird nesting is not adversely impacted.

Migratory shorebirds are also found along the beach of Bogue Banks and may use this area for foraging and roosting habitat. Placement of coarse-gained sediment along the beaches of Bogue Banks will have no adverse effect on migratory shorebirds. A recent year round study in Brunswick County, NC documents observed shorebird use there (USACE 2003). This report indicated that placement of beach-compatible sediment on the beaches in Brunswick County had no measurable impact on bird use.

Therefore, bird species protected by the Migratory Bird Treaty Act of 1918, as amended, would not be adversely affected by the Proposed DMMP.

No long-term adverse impacts to terrestrial resources on Brandt Island, the beaches or dune areas of Bogue Banks are anticipated.

No Action Alternative. Migratory birds may also use Brandt Island for foraging, nesting, and roosting habitat within the migratory bird nesting season from April 1 to August 31 of any year. However, as stated above, the NC Wildlife Resources Commission considers Brandt Island as low quality migratory bird habitat.

As with the proposed plan, if work is initiated on Brandt Island within the migratory bird nesting season (April1 to August 31), the USACE would coordinate with representatives from the NC Wildlife Resources Commission to ensure that migratory bird nesting is not adversely impacted.

Migratory shorebirds are found along the beaches of Bogue Banks and use this area for foraging and roosting habitat. Placement of coarse-grained sediment along the beaches of Bogue Banks would have no significant adverse effect on migratory shorebirds.

The No Action plan is not expected to adversely impact any terrestrial resources found on Brandt Island and along the beach or the dune areas of Bogue Banks.

5.8 Threatened and Endangered Species (includes State Protected Species)

On September 30, 2013, the USFWS published in the Federal Register (50 CFR Part 17) their proposal to list the red knot (*Calidris canutus rufa*) as a threatened species under the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531–1543).

On March 25, 2013, the USFWS published in the Federal Register (50 CFR Part 17) its proposal to designate specific areas in the terrestrial environment as critical habitat for the Northwest Atlantic Ocean Distinct Population Segment of the threatened loggerhead sea turtle (*Caretta caretta*) under the ESA. The proposed critical habitat is located in coastal counties in North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi.

Within the proposed dredged material disposal areas for the Morehead City Harbor DMMP, the beaches of Bogue Banks have been designated in the proposed USFWS Critical Habitat Rule as the Northern Recovery Unit, North Carolina, LOGG-T-NC-01 (Bogue Banks in Carteret County) for the loggerhead sea turtle. This unit extends from Beaufort Inlet to Bogue Inlet and includes terrestrial lands from the Mean High Water (MHW) line landward to the toe of the secondary dune or developed structures.

Additionally, on July 18, 2013, the NMFS published in the Federal Register (50 CFR 226) its proposal to designate specific areas in the marine environment as critical habitat for the Atlantic Ocean loggerhead sea turtle Distinct Population Segment (DPS) (*Caretta caretta*) within the Atlantic Ocean under the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531–1543). In the Morehead City Harbor project area, NMFS is proposing to designate two unit descriptions for the loggerhead sea turtle: LOGG-N-2 – Southern Portion of the North Carolina Winter Concentration Area and LOGG-N-3 – Bogue Banks and Bear Island, Carteret and Onslow Counties, NC. The LOGG-N-2 unit is winter habitat only and includes waters from 20 meters (65.6 feet) to 100 meters (328 feet) depth contours. The LOGG-N-3 unit contains nearshore reproductive habitat only and consists of the nearshore ocean from Beaufort Inlet to Bogue Inlet and seaward 1.6 km (1 mile). This unit contains an area adjacent to high density nearshore reproductive habitat (Beaufort Inlet to Bogue Inlet) as well as an area of high density nearshore reproductive habitat (Bogue Inlet to Bear Inlet). Only the LOGG-N-3 unit would be applicable to the proposed Morehead City Harbor DMMP. Unit LOGG-N-2 would not be applicable to the DMMP, since all existing Federal navigation channels and disposal areas are in water depths less than 20 meters (65.6 feet).

Currently, both USFWS' and NMFS' proposals for designating critical habitat for the threatened loggerhead sea turtle have not been finalized. Moreover, the above-mentioned unit descriptions for both USFWS and NMFS could change prior to the final critical habitat designations.

Proposed DMMP. Operational precautions such as adherence to the aforementioned dredging windows for beach placement minimize potential for impacts to shorebirds, sea turtles, West Indian manatees, and whales.

In the Morehead City Harbor, hopper dredging takes place typically from January 1 to March 31 of any year. This is a Wilmington District protocol, and not a specific requirement of the Regional Biological Opinion on hopper dredging by NOAA Fisheries, dated September 25, 1997 (NMFS 1997). NMFS Biological Opinion dated September 25, 1997 authorizes the continued hopper dredging of channels and borrow areas in the southeastern United States.

On 18 September 2008, the USACE provided NMFS with a revised Draft South Atlantic Regional Biological Assessment (SARBA). The USACE' SARBA would authorize the following activities: "*Dredging activities in the coastal waters, navigation channels (including designated Ocean Dredged Material Disposal Sites (ODMDS)), and sand mining areas in the South Atlantic Ocean from North Carolina/Virginia Border through and including Key West, Florida and the Islands of Puerto Rico and the U.S. Virgin Islands (USVI)*". Once NMFS provides the USACE with its Biological Opinion, any new conditions or restrictions would supersede the NMFS Biological Opinion dated September 25, 1997. Hopper dredging within the Morehead City Harbor would comply with any new conditions and/or restrictions of the new NMFS BO.

Disposal of dredged material in the Morehead City ODMDS, the upland diked disposal area on Brandt Island, the nearshore placement areas off Bogue and Shackleford Banks, or pumped directly onto the oceanfront of Bogue Banks would be undertaken in accordance with the terms and conditions of the Morehead City Harbor Biological Opinion issued by the USFWS dated December 7, 1989 and amended April 19, 1993 and July 22, 2003. Should any threatened or endangered species be observed during implementation of Morehead City Harbor DMMP activities, actions to avoid a "take" will be conducted.

The Wilmington District routinely conducts monitoring for seabeach amaranth on Bogue Banks. Observed numbers of plants are highly variable, ranging from zero to 250 plants in a reach for the Fort Macon, Atlantic Beach and Pine Knoll Shores, portions of Bogue Banks.

Beach placement of sand will be conducted between November 16 and April 30 on Bogue Banks to the degree practicable, in order to minimize potential impacts on nesting sea turtles. Also, after placement of dredged material, any affected beach will be monitored for hardness and areas exceeding 500 Cone Penetrometer Units (CPU) will be tilled in order to make them more suitable for sea turtle nesting. Thus, any adverse impacts on sea turtles should be minor. In addition, the portion of beach that receives sand should provide improved nesting habitat for sea turtles as compared to the currently eroded condition of the beach disposal areas.

SUMMARY EFFECT DETERMINATION

Table 5-5 shows the Threatened and Endangered Species summary effect determination for beach disposal and dredging activities associated with the proposed project area (No Effect (NE – green); May Affect Not Likely to Adversely Affect (MANLAA – orange); May Affect Likely to Adversely Affect (MALAA – red), and Not Likely to Adversely Modify (NLAM - orange) Critical Habitat.

Listed Species Within Project Area		Effect Determination	
		Beach Placement Activities (USFWS)	In-Water Dredging Activities (NMFS)
Sea Turtles	Leatherback	MANLAA	MANLAA
	Loggerhead	MANLAA	MALAA
	Green	MANLAA	MALAA
	Kemp's Ridley	NE	MALAA
	Hawksbill	NE	MALAA
Large Whales	Blue, Finback, Sei, and Sperm	NE	NE
	NARW	NE	MANLAA
	Humpback	NE	MANLAA
West Indian Manatee		NE	MANLAA
Roseate Tern		NE	NE
Red Knot		MANLAA	NE
Piping Plover and Critical Wintering Habitat		MANLAA/NLAM	NE
Atlantic Sturgeon		NE	MALAA
Shortnose Sturgeon		NE	NE
Smalltooth Sawfish		NE	NE
Seabeach Amaranth		MANLAA	NE
	Rough-Leaved Loosestrife	NE	NE
	rare butterfly (*Atrytonopsis* new species 1)	NE	NE
	American Alligator	NE	NE
	Eastern Cougar	NE	NE
	Red-cockaded Woodpecker	NE	NE

(Table notes: No Effect (NE = green), May Affect Not Likely to Adversely Affect (MANLAA = orange), and May Affect Likely to Adversely Affect (MALAA = red))

Table 5-5. T & E species effects determination for beach disposal and dredging activities associated with the DMMP

A biological assessment (BA) has been completed (Appendix J) and will be coordinated with USFWS and NMFS during the NEPA process. As indicated in Section 5.00 of the BA (Commitments to Reduce Impacts), the USACE will comply with all previous agreements with the resource agencies. With these commitments in place, for any USFWS terrestrial environment designated as critical habitat, such as LOGG-T-NC-01 (Northern Recovery Unit, North Carolina) , the proposed project will not result in an adverse modification of critical habitat for the threatened loggerhead sea turtle.

Additionally, pursuant to the NMFS Biological Opinion (BO) dated September 25, 1997 and the 2008 USACE revised Draft South Atlantic Regional Biological Assessment (SARBA), the continued hopper dredging of existing navigation channels is authorized and the USACE would comply with all conditions and/or restrictions. Hopper dredging activities will not result in an adverse modification of the NMFS' proposed critical habitat for the threatened loggerhead sea turtle (LOGG-N-3).

State Protected Species (vascular plants and vertebrate animals) are also found on Bogue Banks (Table 4-9). The DMMP impact area would be considered the Bogue Banks ocean beach and nearshore areas off Bogue and Shackleford Banks. The majority of these state protected species in the project area would be shorebirds that use the beaches of Bogue Banks for foraging and roosting habitat. Placement of coarse-grained sediment along the beaches of Bogue Banks will have no adverse effect on shorebirds. A recent year round study in Brunswick County, NC documents observed shorebird use there (USACE 2003). This report indicated that disposal of beach compatible sediment on the beaches in Brunswick County had no measurable impact on bird use. Implementation of the proposed Morehead City Harbor DMMP is not expected to adversely impact State Protected Species.

No Action Alternative. The same operational precautions described above for the proposed DMMP, such as adherence to dredging windows and the terms and conditions of both the NOAA Fisheries' and USFWS' Biological Opinions, would minimize the potential impacts to shorebirds, sea turtles, West Indian manatee, and whales.

Under the No Action alternative, the Wilmington District would continue to monitoring for seabeach amaranth on Bogue Banks. Beach placement of sand would be conducted between November 16 and April 30 to the degree practicable, in order to minimize potential impacts on nesting sea turtles. Also, after placement of dredged material, any affected beach area would be monitored for hardness and areas exceeding 500 CPUs would be tilled in order to make the area more suitable for sea turtle nesting. Thus, any adverse impacts on sea turtles should be minor. In addition, the portion of beach that receives sand should provide improved nesting habitat for sea turtles as compared to the currently eroded condition of the beach disposal areas.

No adverse impacts to Threatened and Endangered species are anticipated, since the USACE will abide by all conditions and restrictions of the NOAA Fisheries and USFWS BOs.

5.9 Cultural Resources

It is anticipated that resources in the area will be limited to shipwrecks that may be impacted by direct deposit of dredged material or by induced changes in current patterns. Dredged material disposal impacts to submerged cultural resources are often considered benign; however, assessment of impacts must consider the susceptibility of known resources to three major routes of impact: direct impact from placement of material, the chemical composition of the dredged material and its potential to erode a site, and the potential for changes in bottom contours to affect current patterns and influence the deposition environment.

Archival records and past investigations by private firms, the State of North Carolina, and the Wilmington District have located and identified several important shipwrecks in the Beaufort Inlet vicinity. In addition, magnetic and acoustic anomalies have been identified in the proposed Bogue and Shackleford nearshore placement areas (USACE 2010a).

The continued maintenance of Morehead City Harbor will not adversely impact the Fort Macon historic site. Since 1910, the Corps has maintained Morehead City Harbor. The USACE Section 111 report (USACE 2001) determined that the historic beach disposal activities have ameliorated any shoreline impacts related to the dredging of the navigation channel. Additionally, the Section 111 report (USACE 2001) determined that there were no significant changes to the shoreline recession rate beyond the Atlantic Beach town limits that are related to the navigation project.

Proposed DMMP. Direct project impacts will be limited to submerged cultural resources and are likely to be minimal. The actual extent of impact will depend on the amount of material placed on or near cultural resources and the chemical composition of the material. If beach quality or near beach quality material is deposited, chemical impacts will be minimal or non-existent. If dredged material release locations are specified in the contract and are monitored so that no mounding occurs on or near cultural resources, then effects from altered current are also likely to be minimal or non-existent.

The Underwater Archaeology Branch (UAB) of the North Carolina Office of State Archaeology will be consulted prior to dredging and disposal activities. Furthermore, UAB will be provided the hydrographic data resulting from the monitoring plan. The data, particularly in the areas of known or suspected cultural resources, will allow the Wilmington District and UAB to assess any project effects on cultural resources within the project area.

A special restricted zone will be required in the vicinity of the *Queen Anne's Revenge*, west of Beaufort Inlet. This area continues to be actively surveyed by both public and private interests. An Admiralty Claim may be in effect at the time of project implementation and could effectively limit the areas within which dredges might operate.

The Morehead City Harbor DMMP study has been reviewed for possible cultural resources impacts pursuant to Section 106 of the National Historic Preservation Act (16 USC 470 et seq.), the Abandoned Shipwreck Act (43 USC 2101 et seq.), and North Carolina statute G.S. 121-22 to 28, Article 3, which gives the state control of salvaged of abandoned shipwrecks and other underwater archaeological material on all bottoms from low water to one marine league seaward and on bottoms of other navigable waters. The DMMP project review is being conducted in accordance with implementing regulations found at 36 CFR 800, *Protection of Historic Properties*.

This review has included past research reports, consultation with the North Carolina State Historic Preservation Officer and staff of the NC Division of Archives and History Underwater Archaeology Unit. The review indicates that six archaeological sites have been recorded along the Bogue Banks beaches and two have been recorded offshore. In addition, archaeologists have identified numerous clusters of offshore magnetic and sonar targets, some of which have been verified as cultural remains. Some of the known sites consist of transient wreckage that has washed ashore from ships lost nearby in offshore waters. The verified sites and their last known locations are (NAD83 datum, UTM Zone 18):

0001BBB Iron Steamer Pier Wreck Site (3840366N, 0332561E)
Believed to be the Civil War blockade-runner *Pevensey*, an iron-hull side-wheel steamer, lost June 9, 1864. The wreck is located approximately 100 yards offshore on the east side of the pier lying almost parallel to the beach. Portions of a paddle wheel are visible during low tide.

0002BBB Gun Emplacement Site (3838105N, 0317035E)
Granite stones located in the surf zone adjacent to the 6200 block of Ocean Drive at Emerald Isle, believed to be from a World War II coastal shore battery exposed by beach erosion.

0003BBB Salter Path Site (No position given)
Ship timbers 14” square, approximately 42 feet and 18 feet long with 1.25” diameter iron fasteners located roughly 1200 feet east of the beach access road near Squatters Campground.

0004BBB Cupola Site (3839081N, 0322515E)
Portions of a ship hull approximately 30’ long and 14’ wide fastened with iron pins, yellow pine planking on oak frames. This site is located in the surf zone near 18th Street, Emerald Isle. (Tag Numbers 134, 135)

0005BBB Emerald Isle Pier Wreck (3838758N, 0320674E)
Ship timber 40’ long, 12” x 18” square, iron fasteners and one attached frame. This site is located near Emerald Isle Fishing Pier. (Tag Numbers 155, 156)

0006BBB Ocean Reef Site (3838806N, 0320892E)
Ship wreckage covering an area of approximately 100’ by 35’ near the Ocean Reef Condos (marked by a warning sign on the beach). This site consists of extensive debris with iron fasteners.

0003BUI Queen Anne’s Revenge (location restricted). This shipwreck dates to 1718 and was the primary vessel of the pirate, Black Beard. This site is listed on the

National Register of Historic Places and is managed by the NC Division of Archives and History.

0000SFB Quinnabaugh. This site is located offshore of Shackleford Banks, east of Beaufort Inlet. The site has been visited by research divers and appears to be the remains of steam machinery from the wreck.

If a pipeline dredge is used for direct placement in the nearshore placement areas, a spill barge might need to be anchored within the nearshore areas to direct the discharge of sediment from the pipeline dredge. In order to avoid cultural resources, both the pipeline route (from the dredge to the nearshore area) and the location of the spill barge anchoring area would be coordinated with the NC State Historic Preservation Office (SHPO) and UAU.

The USACE agrees to work closely with the NC State Historic Preservation Office (SHPO) and UAU regarding the placement of sediment in the nearshore areas off Bogue and Shackleford Banks. Additionally, copies of all surveys of the Beaufort Inlet area will be provided to these agencies. The proposed DMMP will not adversely impact cultural resources.

No Action Alternative. Continued maintenance dredging of Morehead City Harbor channels and use of approved disposal areas would not have adverse effects on cultural resources.

5.10 Aesthetic and Recreational Resources (Including Soundscape)

Proposed DMMP. Expansion of the beach area would improve aesthetics and recreational quality for beach users. Recreation benefits for the proposed project would result from increased quality of the recreation experience. The aesthetic quality of Bogue Banks beaches would be temporarily impacted by the noise and visual intrusion of the dredge and associated pipes and equipment during placement of dredged material on the beach. Within the sediment placement areas off Bogue and Shackleford Banks, boat and human traffic access would be restricted for safety reasons during placement activities. Additionally, since all work on these beaches would take place during the off season (November 16 to April 30 on Bogue Banks) and up to a maximum of 200 feet a day, the USACE believes that these impacts are temporary and not significant.

Surf Break off Shackleford Banks: The surf break extends from the spit (off Beaufort Inlet) to about 4,000 to 6,000 feet east to Rough Point on Shackleford Banks. The nearshore placement area off Shackleford Banks was selected to reduce the deflation of the eastern lobe of the Beaufort Inlet Ebb Tide Delta. Because of the existing steep offshore beach profiles in the vicinity of the Shackleford Banks spit that’s on the west end of the island, the relatively small amount of sediment to be placed within the nearshore placement area off Shackleford Banks, and its high rate of erosion, the

USACE does not anticipate that sediment movement from the Nearshore East would adversely impact the surf break.

No Action Alternative. The No Action alternative has improved and expanded the existing beaches within the town of Atlantic Beach and Fort Macon State Park and this would be expected to continue. Only beaches on Bogue Banks would be impacted. Recreation benefits have increased due to the increase of the existing beaches on Bogue Banks. During disposal activities the aesthetic quality of the Bogue Banks beaches would be temporarily impacted by the noise and visual intrusion of the dredge, associated shore pipes, temporary safety fencing, and equipment during placement of dredged material on the beach. However, all work would be conducted during the off-season (16 November to April 30) and the work area on the beach extends a maximum of 200 feet a day. Therefore, the USACE believes that these impacts would be temporary and insignificant.

5.11 Recreational and Commercial Fishing

Proposed DMMP. Beach placement on Bogue Banks will proceed up or down the beach progressing at slow rate of about one mile a month or 200 feet of beach per day. Fishing activities (such as surf or seine fishing from the beach strand or from the two ocean piers) will be precluded from the immediate vicinity of the discharge during construction and maintenance. During past beach placement events, a buffer on either side of these ocean piers has been maintained so as not to adversely impact these structures. Employment of buffers during future beach placement events would be coordinated with the appropriate pier owners. Portions of the project area that have been recently completed and those awaiting disposal would be accessible for fishing. The immediate construction area is small relative to nearby available fishing areas that could be accessed by numerous beach access points located throughout the project area. Discharge pipelines along the beach that cross established vehicle access points would be ramped as practical to facilitate continued use.

Commercial trawlers would not be able to operate in dredging areas and in any immediate areas occupied by pipelines during maintenance operations. No permanent disposal of equipment is proposed. Dredging with beach disposal on Bogue Banks is proposed to occur from November 16 through April 30 No permanent placement of equipment is proposed. Only a limited area of open-ocean would be occupied by equipment (hopper and pipeline dredges) in relation to available recreational and commercial fishing areas.

No Action Alternative. Fishing activities (such as surf or seine fishing from the beach strand) would not be precluded for a majority of the time due to limited beach placement. Portions of the project area that have been recently completed and those awaiting disposal would be accessible for fishing. There would be no change in recreational fishing opportunities from those currently in existence along the beach strand.

Commercial trawlers would not be able to operate in construction areas. No permanent placement of equipment is proposed. Only a limited area of open-ocean would be occupied by equipment (i.e., hopper and pipeline dredges) in relation to available fishing areas.

5.12 Socioeconomics

Proposed DMMP. Implementation of the proposed plan would not result in any adverse effects to any socioeconomic resources. Positive benefits are expected as a result of placement of coarse-grained dredged material on portions of the oceanfront of Bogue Banks. Continued placement of sand on the beaches of Bogue Banks may contribute to increased beach real estate values and reduce anthropogenic effects. These proposed sand placement activities on Bogue Banks would also increase benefits to tourism in the area.

No Action Alternative. Continuation of the No Action plan will not result in any adverse effects to socioeconomic resources. Positive benefits are expected as a result of placement of coarse-grained dredged material on portions of the ocean front of Bogue Banks. Continued sand placement on the beaches of Bogue Banks may contribute to increased beach real estate values, tourism in the area, and reduce anthropogenic effects.

5.13 Other Significant Resources (Section 122, P.L. 91-611)

5.13.1 Air, Noise, and Water Pollution

a. Air Quality. The air quality in Carteret County, North Carolina, is designated as an attainment area (Section 4.4 Air Quality). The State of North Carolina does have a State Implementation Plan ("SIP") approved or promulgated under Section 110 of the Clean Air Act (CAA), as amended. However, a conformity determination is not required because Carteret County has been designated by the State of North Carolina as an attainment area, and the direct and indirect emissions from the project fall below the prescribed *de minimus* levels (58 Fed. Reg. 93.153(c)(1)) and; therefore, no conformity determination would be required.

Implementation of the proposed DMMP or the No Action plan would not adversely impact air quality in the project area.

b. Noise. Noise in the outside environment associated with beach and nearshore placement activities would be expected to minimally exceed normal ambient noise in the project area; however, construction noise would be attenuated by background sounds from wind and surf. In-water noise would be expected in association with the dredging and placement activities for this project. Specifically, noise associated with dredging could occur from (1) ship/machinery noise—noise associated with onboard machinery and propeller and thruster noise, (2) pump noise—noise associated with pump driving the suction through the pipe, (3) collection noise—noise associated with the operation and collection of material on the sea floor, (4) deposition noise—noise associated with the placement of the material within the barge or hopper, and (5) transport noise—noise associated with transport of material up the suction pipe. The limited available data indicate that dredging is not as noisy as seismic surveys, pile driving and sonar; but it is louder than, for example, most shipping, operation of offshore wind turbines and drilling (Thomsen et al. 2009).

Dredging produces broadband and continuous, low-frequency sound (below 1 kHz) and estimated source sound pressure levels range between 168 and 186 dB reference (re) level of 1 µPa at 1 m (A micropascal (µPa) is a measurement of pressure commonly applied to underwater sound and 1 pascal is equal to the pressure exerted by one newton over one square meter.), which can trigger avoidance reaction in marine mammals and marine fish. In some instances, physical auditory damage can occur. Auditory damage is the physical reduction in hearing sensitivity due to exposure to high-intensity sound and can be either temporary (temporary threshold shift) or permanent (permanent threshold Shift) depending on the exposure level and duration. Other than physical damage, the key auditory effect is the increase in background noise levels, such that the ability of an animal to detect a relevant sound signal is diminished, which is known as *auditory masking*. Masking marine mammal vocalizations used for finding prey, navigation and social cohesion could compromise the ecological fitness of populations (Compton et al. 2008).

According to Richardson et al. (1995) the following noise levels could be detrimental to marine mammals: Prolonged exposure of 140 dB re (level of) 1 µPa/m (continuous man-made noise), at 1 km can cause permanent hearing loss. Prolonged exposure of 195 to 225 dB re (level of) 1 µPa/m (intermittent noise), at a few meters or tens of meters, can cause immediate hearing damage.

According to Richardson et al. (1995), “Many marine mammals would avoid these noisy locations, although it is not certain that all would do so.” In a study evaluating specific reaction of bowhead whales to underwater drilling and dredge noise, Richardson et al. (1990) also noted that bowhead whales often move away when exposed to drillship and dredge sound; however, the reactions are quite variable and can be dependent on habituation and sensitivity of individual animals. According to Richardson et al (1995), received noise levels diminish by about 60 dB between the noise source and a radius of 1 km. For marine mammals to be exposed to a received level of 140 dB at 1-km radius, the source level would have to be about 200 dB re (level of) 1 µPa/m. Furthermore, few human activities emit continuous sounds at source levels greater than or equal to 200 dB re (level of) 1 µPa/m; however, supertankers and icebreakers can exceed the 195 dB noise levels.

According to Clarke et al. (2002), hopper dredge operations had the highest sustained pressure levels of 120–140 dB among the three measured dredge types; however, the measurement was taken at 40 m from the operating vessel and would likely attenuate significantly with increased distance from the dredge. On the basis of (1) the predicted noise effect thresholds noted by Richardson et al. (1995), (2) the background noise that already exists in the marine environment, and (3) the ability of marine mammals to move away from the immediate noise source, noise generated by bucket, cutterhead, and hopper dredge activities would not be expected to affect the migration, nursing/breeding, feeding/sheltering or communication of large whales. Although behavioral effects are possible (i.e., a whale changing course to move away from a vessel), the number and frequency of vessels present in a given project area is would be small, and any behavioral impacts would be expected to be minor. Furthermore, for hopper dredging activities, endangered species observers would be onboard and would record all large whale sightings and note any potential behavioral impacts. Per the standard USACE specifications for all dredging projects, the USACE and the contractor would keep the date, time, and approximate location of all marine mammal sightings. Care would be taken not to closely approach (within 300 ft.) any whales, manatees, or other marine mammals during dredging operations or transportation of dredged material. An observer would serve as a lookout to alert the dredge operator or vessel pilot or both of the occurrence of the animals. If any marine mammals are observed during other dredging operations, including vessel movements and transit to the dredged material disposal site, collisions must be avoided either through reduced vessel speed, course alteration, or both. During the evening hours, when there is limited visibility from fog, or when there are sea states of greater than Beaufort 3 (wind speed of 8-12 miles per hour), the dredge must slow down to 5 knots or less when transiting between areas if whales have been spotted within 15 nautical miles of the vessel's path in the previous 24 hours. Sightings of whales or manatees (alive, injured, or dead) in the work area must be reported to NMFS Whale Stranding Network.

Similar to conclusions made regarding effects of sound on marine mammals, non-injurious impacts to sea turtles may also occur because of acoustic annoyance or discomfort. It has been hypothesized, on the basis of anatomical studies that sea turtle hearing range centers around low-frequency sounds. Ridgeway et al. (1969 and 1970) evaluated the frequency sensitivity of green sea turtles and found that green turtles detect limited sound frequencies (200–700 Hz) and display high level of sensitivity at the low-tone region (approx 400 Hz). According to Bartol et al. (1999), the most sensitive threshold for loggerhead sea turtles is 250–750 Hz with the most sensitive threshold at 250 Hz. Though noise generated from dredging equipment is within the hearing range of sea turtles, no injurious effects would be expected because sea turtles can move from the area, and the significance of the noise generated by the dredging equipment dissipates with an increasing distance from the noise source.

Proposed DMMP. The proposed DMMP will not significantly increase unavoidable noise in the project area. Temporary and short-term increases in noise levels are anticipated during construction activities on Bogue Banks but all work will occur during the off season (November 16 to April 30 on Bogue Banks) and within a small footprint on the beach. Therefore, no adverse impacts are anticipated.

No Action Alternative. The No Action alternative has not significantly increased the noise levels in the project area. Temporary and short-term increases in noise levels are anticipated during construction activities on Bogue Banks but all work would occur during the off season (November 16 to April 30 of any year for pipeline dredges) and within a relatively small footprint on the beach. No significant adverse impacts have occurred as a result of this activity.

c. Water Pollution. Water Quality in the project area is thoroughly discussed in Section 5.3.01 of the Integrated DMMP and DEIS. No adverse impacts are anticipated for both the proposed DMMP and the No Action alternative.

5.13.2 Man-made & Natural Resources, Aesthetic Values, Community Cohesion, & Availability of Public Facilities & Services

No adverse impacts to Man-made and Natural Resources, Aesthetic Values, Community Cohesion, and the Availability of Public Facilities and Services are expected as a result of the Proposed DMMP or the No Action plan.

5.13.3 Hazardous, Toxic and Radioactive Waste (HTRW)

No HTRW sites are located in the project area and therefore neither the proposed DMMP nor the No Action plan will impact any HTRW sites. Also, neither plan would result in the disposal of contaminated sediments in any disposal areas within the project area.

5.14 Employment, Tax, and Property Values

No adverse effects on employment, tax, and property value are expected as a result of the proposed DMMP or the No Action plan.

5.15 Displacement of People, Businesses, and Farms

No people, homes or businesses will be displaced by the proposed DMMP or No Action plan. Additionally, there will be no utility relocations. Also, no farms would be affected by the proposed DMMP or the No Action plan.

5.16 Community and Regional Growth

Communities in the Morehead City Harbor vicinity have been experiencing rapid growth during the last few decades. This growth is expected to continue with or without the proposed DMMP or No Action plan.

5.17 Cumulative Effects

The Council on Environmental Quality (CEQ) defines cumulative impact as:

The impact on the environment which results from the incremental impact of the action when added to other past, present and reasonably foreseeable actions regardless of *what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (*40 CFR 1508.7). This analysis follows the 11-step process outlined by the Council on Environmental Quality (CEQ) in their 1997 publication Considering Cumulative Effects Under the National Environmental Policy Act (Appendix K).

Proposed DMMP. The detailed analysis of cumulative effects is included in Appendix K. The assessment of cumulative effects focused on effects of the following: 1) the proposed future expansion of the Port of Morehead City on Radio Island; 2) continued maintenance dredging within the existing federal navigation channels; 3) effects of placing maintenance sediment in the nearshore area; and 4) effects of placing sediment on the beaches of Bogue Banks on significant coastal shoreline resources.

1. Proposed Port Expansion on Radio Island. The NC State Ports Authority (NCSPA) is pursuing port industrial development on Radio Island and has completed the NEPA document for this action (NCSPA 2001). Currently, NCSPA has not obtained the necessary authorizations from the Regulatory Division, Wilmington District, USACE (i.e., Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act permits) and the State of North Carolina to complete this activity. Moreover, funding for the proposed port expansion has not been approved by the North Carolina State Legislature and no new or existing customer of the port facility has requested to fund this proposed action.

At this time, the USACE does not know when or if this expansion project will be completed. Nor does the USACE know the specific disposal locations of the approximately 1.7 million cubic yards of dredged material and/or the maintenance interval of the expanded Harbor channels. Discussions with representatives from the NCSPA (Personnel Communication, Mr. Todd Walton, Environmental Supervisor, NCSPA, May 6, 1015) indicate that NCSPA are still interested in pursuing this action but they don't know when or if this will occur.

2. Effects of Continued Maintenance Dredging in the Morehead City Harbor. Benthic organisms within the defined federal navigation channels would be lost. The benthic organisms found in the areas adjacent to the federal navigation channels would not be impacted and would provide benthic populations for recolonization. However, these federal channels have been maintained for many years. Construction of Morehead City Harbor was authorized in 1910 and over the years the entrance and Inner Harbor channels have been widened and deepened to their present width and depth. The proposed DMMP will continue maintenance of the existing Harbor channels with no deepening or widening proposed for the next 20 years. Maintenance dredging of the existing federal navigation channels would continue to be accomplished by pipeline, hopper and/or bucket and barge would not cause any long term impacts in the project area. The proposed DMMP would not cause adverse cumulative impacts.

3. Effects of Maintenance Sediment Placed in the Nearshore Area. Figures 3-25 and 3-26 show the proposed nearshore placement areas for the DMMP, which include the following: 1) An additional 1,209 acres of nearshore placement area off Bogue Banks (total of 559 acres existing plus 1,209 or 1,768 acres); and 2) New 492 acres of nearshore placement area off Shackleford Banks. A total of about 1,701 acres of new nearshore area off Bogue and Shackleford Banks would be impacted by the proposed DMMP. Both nearshore areas off Bogue and Shackleford Banks are located within the littoral zone and any sediment placed in these areas would reduce or minimize any future deflation of the Beaufort Inlet Ebb Tide Delta (discussed in Section 3.2.4 Ebb Tide Delta).

The USACE believes that placement coarse-grained sand (90% or greater sand) within the nearshore areas off Bogue and Shackleford Banks will not cause any significant environmental adverse impacts since the existing substrate in the nearshore areas is similar to the sediments that will be placed in these areas. No significant increase in turbidity is expected since the nearshore sites are located within the surf zone. Additionally, no hardbottoms would be adversely impacted by the placement of sediment in these nearshore areas. No dredged material would be lost to the system by placing it in the ODMDS. The following benefits would accrue: 1. Reduce or minimize the deflation of the Beaufort Ebb Tide Delta, 2. Increase the amount of coarse-grained sand migrating to the ocean beaches while the fine-grained material should migrate offshore, and 3. Provide additional habitat for infauna species.

No adverse cumulative impacts to the nearshore area are anticipated for the proposed DMMP. Sediment placement activities on the existing nearshore area off Bogue Banks have occurred many times over the years. The USACE believes that placement of sediment in nearshore areas of Bogue and Shackleford Banks will slow or minimize the continued deflation of the Ebb Tide Delta and ameliorate erosion of the adjacent beaches.

4. Effects of Maintenance Dredged Sediment Placed on the beaches of Bogue Banks. The DMMP may place suitable sediment (90% or greater sand) on up to 10.5 miles of beach from Fort Macon State Park to about Pine Knoll Shores (Figure 3-12) on Bogue Banks. The proposed DMMP plans to place suitable sediment on the beaches of Bogue Banks once every three years.

There are two reasonably foreseeable projects on Bogue Banks and these are; the Bogue Banks Coastal Storm Damage Reduction (CSDR) Project and any private beach nourishment projects. Both of these reasonably foreseeable projects on Bogue Banks would continue to place beach quality sediment on the same beaches that have been previously nourished. No new beach disposal areas on Bogue Banks will be impacted by the proposed DMMP.

Relatively small portions of North Carolina beaches are presently affected by the beach disposal or placement of sand from maintenance activities, about 6%. With the proposed DMMP, the impact area would not increase on Bogue Banks since all beach placement areas proposed have been previously impacted by projects undertaken by both the USACE and Carteret County. On a statewide scale the existing and approved disposal sites are well distributed in northern central and southern parts of the state with undeveloped protected beaches (i.e., National/federal and State Parks and Estuarine Reserves) in between. It is unlikely that cumulative impacts from space crowded perturbation are occurring or will occur due to the implementation of this DMMP. The analysis suggests that the potential impact area from the proposed and existing actions is small relative to the area of available similar habitat on a vicinity and statewide basis. These areas are expected to recover food resources, which should continue to be available. It is expected that the risk that the direct and cumulative impacts of the proposed action and other existing similar activities, would reach a threshold with high potential for population level impacts on important commercial fish stocks and birds is low.

No adverse cumulative impacts are anticipated to the Bogue Banks Area for the proposed DMMP. Sediment placement activities on the beaches of Bogue Banks have occurred many times over the years. The USACE also believes that disposal of sediment on the beaches of Bogue Banks and in the nearshore areas off Bogue and Shackleford Banks will slow or minimize the continued deflation of the Beaufort Ebb Tide Delta and reduce future erosion.

No Action Alternative. The dredged material disposal for the No Action alternative is:

- Inner Harbor material would be disposed of in Brandt Island or the ODMDS.
- Outer Harbor coarse-grained material would be disposed of on the beaches of Fort Macon State Park and Atlantic Beach and/or placed in the existing Western nearshore placement (Ebb Tide Delta) area off Bogue Banks.
- Outer Harbor Entrance channel material would be disposed of in the ODMDS.

The beach placement areas from Fort Macon State Park to the Town of Atlantic Beach have occurred many times over the years. Both the USACE and Carteret County have placed suitable sediment in these beach areas. The IOP does not include the placement of dredged material on Shackleford Banks.

No adverse cumulative impacts are anticipated as a result of implementation of the No Action alternative on Bogue Banks. However, the No Action alternative will not place sediment on Shackleford Banks or in the nearshore area to the east of Beaufort Inlet, which may result in the continued the long-term erosion of the island and deflation of the eastern side of the Beaufort Inlet Ebb Tide Delta.

As indicated previously a more detailed cumulative impact analysis is found in Appendix K of the DMMP. The following discussion summarizes the cumulative impact conclusions mentioned in Appendix K:

Historically, the extent of beach disposal/nourishment activities on beaches within the geographic area from Cape Lookout to Cape Fear was limited to a few authorized federal projects including: Wrightsville Beach, Carolina and Kure Beaches. However, in the past 10 years, a significant number of federal and nonfederal beach nourishment efforts were pursued to provide coastal storm damage reduction along the increasingly developed North Carolina shoreline. Additionally, the number of non-federal permitted beach nourishment projects has increased in recent years in efforts to initiate coastal storm damage reduction measures in the interim of federal projects being authorized and/or funded (i.e. North Topsail Beach, and Topsail Beach, and Bogue Banks). Furthermore, the frequency of beach disposal activities for protection of infrastructure will continue throughout the state resulting in cumulative time and space crowded perturbations. However, assuming projects continue to adhere to environmental commitments for the reduction of environmental impacts, and un-developed beaches throughout the state continue to remain undisturbed, it is likely that adjacent un-impacted and/or recovered portions of beach will be available to support dependent species (i.e. surf zone fish, shore birds, etc.) and facilitate recovery of individual project sites to pre-project conditions. Assuming recovery of impacted beaches and the sustainability of undeveloped protected beaches (i.e. National/Federal and State Parks and Estuarine Reserves) the potential impact area of the proposed DMMP on Bogue Banks as well as existing actions is small relative to the area of available similar habitat on a vicinity and statewide basis. The proposed DMMP will not increase the area of North Carolina beaches affected by sand disposal. Therefore the DMMP will not significantly increase cumulative impacts in the immediate project area or within the geographic scope of the cumulative assessment.

6 STATUS OF ENVIRONMENTAL COMPLIANCE ACTIONS FOR THE PROPOSED DMMP, COORDINATION AND DOCUMENTATION

The following section briefly discusses the status of the environmental compliance, coordination and documentation for the proposed DMMP.

As stated in previous sections, the sediment disposal for the proposed DMMP is: Fine-grained material from the Inner Harbor will be disposed in Brandt Island and/or the ODMDS. Predominantly sandy material from the Inner Harbor may be placed in either the proposed Nearshore West and East or in Brandt Island; coarse-grained material from the Outer Harbor will be placed either in the expanded Nearshore West and East (with minor amounts going to the ODMDS during inclement weather) or on the beaches of Bogue Banks; and Outer Harbor Entrance channel material will be disposed in ODMDS.

6.1 Water Quality (including Section 401 Certification)

A Section 404(b)(1) evaluation will be required for the return of effluent discharged from Brandt Island and the proposed placement of maintenance dredged material on the beaches Bogue Banks and in the nearshore placement areas. The Section 404(b)(1) evaluation that addresses these discharges is found in Appendix H.

Return of effluent from Brandt Island can be controlled such that water released from the diked area has little or no suspended solids. Proper management of releases from Brandt Island will not result in turbidity levels above 25 NTUs in the area of the spillway pipe outfall.

On March 19, 2012, the NCDWR re-issued 401 general water quality certifications that cover the following dredged material disposal options: beach placement on Bogue Banks (NCDWR Certificate # 3908), nearshore sediment disposal off Bogue and Shackleford Banks (NCDWR Certificate # 3908), and upland diked disposal activities on Brandt Island (NCDWR Certificate # 3888). Copies of these general water quality certificates are found in Appendix D. All conditions and requirements of the water quality certifications will be adhered to in the implementation of the proposed DMMP.

6.2 Ocean Dumping

The proposed DMMP will continue to use the EPA-designated Morehead City ODMDS. The dredged material proposed for ocean disposal has previously been evaluated for compliance with EPA's Ocean Dumping Regulations and Criteria and are, therefore, not considered significantly contaminated and are acceptable for transportation for ocean dumping under Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972, as amended. The USEPA, Region 4 has concurred with all previous Section 103 evaluations. Periodic re-evaluations will be performed as required by EPA and USACE policy.

All disposal activities at the Morehead City Ocean Dredged Material Disposal Site (ODMDS) must be conducted in accordance with the Site Management and Monitoring Plan (SMMP), dated February 2010 (USEPA and USACE, 2010). All Section 103 ocean disposal permits or concurrences shall be conditioned as necessary to assure consistency with the SMMP dated February 2010.

6.3 US Fish and Wildlife Coordination Act

Since the Morehead City Harbor DMMP is strictly for the disposal of maintenance dredged material from an existing navigation channel, a formal Draft and Final Coordination Act Report is not required from USFWS. However, the USACE has prepared and will coordinate a Biological Assessment (Appendix J) with USFWS and the NMFS regarding project impacts to threatened and endangered (T&E) plants and animals and their habitats pursuant to the Endangered Species Act (ESA) of 1973, as amended. Moreover USFWS is an active member of the PDT and will remain so throughout the NEPA process.

6.4 Endangered and Threatened Species (includes State Protected Species)

A biological assessment (Appendix J) evaluating the potential impacts of the proposed action on endangered and threatened species has been prepared and will be coordinated with the USFWS (jurisdiction over the Florida manatee, Piping Plover and its designated critical wintering habitat, nesting sea turtles, and seabeach amaranth) and NMFS (jurisdiction over other protected marine and aquatic species which may occur in the project vicinity) pursuant to Section 7 of the Endangered Species Act of 1973 (PL 93-205), as amended. Compliance obligations under Section 7 will be satisfied prior to implementation of the proposed action.

In the Morehead City Harbor, hopper dredging takes place typically from January 1 to March 31 of any year and complies with the terms and conditions of the Regional Biological Opinion on hopper dredging by NOAA Fisheries, dated September 25, 1997 (NMFS 1997). The NMFS Biological Opinion dated September 25, 1997 authorizes the continued hopper dredging of channels and borrow areas in the Southeastern United States.

On 18 September 2008, the USACE provided NMFS with a revised Draft South Atlantic Regional Biological Assessment (SARBA). The USACE' SARBA would authorize the following activities: "*Dredging activities in the coastal waters, navigation channels (including designated Ocean Dredged Material Disposal Sites (ODMDS), and sand mining areas in the South Atlantic Ocean from North Carolina/Virginia Border through and including Key West, Florida and the Islands of Puerto Rico and the U.S. Virgin Islands (USVI)*". Once NMFS provides the USACE with their Biological Opinion, any new conditions or restrictions would supersede the NMFS Biological Opinion dated September 25, 1997. Hopper dredging within the Morehead City Harbor would comply with any new conditions and/or restrictions found within the new NMFS BO.

The State Protected Species found in Table 4-9 will not be adversely affected by any component of the DMMP.

6.5 Essential Fish Habitat

Coordination required by the 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA (PL 94-265)) will be completed through the NEPA process, prior to implementation of the DMMP.

6.6 Executive Order 11593 (Protection and Enhancement of the Cultural Environment)

Pursuant to 36 CFR Section 800.4, the Wilmington District has completed a cultural resources and hard bottom remote sensing survey over the DMMP project areas. In addition, Intersal Corporation is conducting research in much of the same area under North Carolina exploratory permits. The placement area is considered sensitive due to known resources, particularly *Queen Anne's Revenge,* listed in the National Register of

Historic Places, and sites such as the *USS Quinnabaugh*, the *L. A. Bailey*, and the *Parkins*. In addition, several privately funded research efforts have been conducted, and the location data will be shared with the USACE and documented in the recently completed remote sensing surveys. One of these private surveys identified 214 magnetic/sonar targets in and around the western project area. Of these, 26 were found to be items of interest for further investigation (old stock anchors, cannon, ship fittings).

The most recent private research is being conducted pursuant to a State permit issued to Intersal Corporation for further exploration within and adjacent to the proposed placement areas. Intersal's detailed survey and site investigations are still in progress, and will be integrated with the recent research conducted by Tidewater Atlantic Research for the Wilmington District. The Tidewater Atlantic research, conducted at a Phase I level, has identified up to 193 sonar and/or magnetic targets that may be associated with historic shipwrecks or navigation debris.

Consultation has been initiated with the NC SHPO through the state's Underwater Archaeology Branch (UAB). Intersal is also considered a consulting party under terms of Section 106 NHPA, per 36 CFR Part 800. Although the UAB acknowledges that deposition may preserve shipwreck remains, any mounding or introduction of contaminated sediments may adversely affect shipwreck remains by altering natural deposition and thereby causing erosion. In order for the State to fully concur with a no adverse effect determination, the USACE will have to agree to specifying placement methods in the construction contract that ensure material is equally distributed throughout the designated placement areas. In addition, the Wilmington District and the State will enter into a cooperative program to regularly share GIS data so that sediment deposition and transport can be monitored. This will entail meetings between UAB, Wilmington District, and possibly contractor GIS experts so that available data can be discussed, evaluated, and program success measured.

Per 36 CFR Section 800.5, a No Adverse Effect determination may be obtained once an agreement is reached on placement method and monitoring.

If a pipeline dredge is used for direct placement in the nearshore placement areas, a spill barge might need to be anchored within the nearshore areas to direct the discharge of sediment from the pipeline dredge. In order to avoid adverse impacts to cultural resources, both the pipeline route (from the dredge to the nearshore area) and the location of the spill barge anchoring area would be coordinated with the NC State Historic Preservation Office (SHPO) and UAU.

6.7 Executive Order 11988 (Floodplain Management)

Dredged material would be placed in the floodplain adjacent to the Bogue Banks beaches. The proposed action is not anticipated to induce development of the floodplain, or to otherwise adversely affect any floodplain, since the existing oceanfront property is developed. The proposed action is in compliance with the requirements of Executive Order 11988.

No practical alternative exists to locating components of the proposed project in the floodplain. Every effort will be taken to minimize potential effects within the flood plain. The action is in compliance with State/local floodplain protection standards.

6.8 Executive Order 11990 (Protection of Wetlands)

Implementation of the DMMP will not require filling any wetlands on Brandt Island and/or the beaches of Bogue Banks (Fort Macon State Park or Atlantic Beach). Additionally, the proposed work will not produce any significant hydrologic or salinity changes affecting any wetlands. The proposed action is in compliance with Executive Order 11990.

Additionally, implementation of the DMMP would not adversely impact benthic resources (Sections 5.5.2 and 5.5.3 Benthic Resources – Beach and Surf Zone and Nearshore Ocean), sediment composition, including grain size, and color (Section 5.1.2 Sediment Characteristics), and recovery times of organisms (Sections 5.5.2 and 5.5.3 Benthic Resources – Beach and Surf Zone and Nearshore Ocean).

6.9 Executive Order 13186 (Protection of Migratory Birds)

This Executive Order mandates agencies to protect and conserve migratory birds and their habitats pursuant to the Migratory Bird Treaty Act of 1918, as amended.

Migratory shorebirds are found along the beaches of Bogue and Shackleford Banks and use these areas for foraging and roosting habitat. The proposed action would restore and increase the habitat along Bogue Banks for migratory birds.

Migratory birds may also use Brandt Island for foraging, nesting, and roosting habitat within the migratory bird nesting season from April 1 to August 31 of any year. However, as previously discussed, the NC Wildlife Resources Commission indicates they consider Brandt Island as low quality migratory bird If any work is initiated on Brandt Island within the migratory bird nesting season (April 1 to August 31), USACE will coordinate with representatives from the NC Wildlife Resources Commission to ensure that migratory bird nesting is not adversely impacted. Implementation of the DMMP will have no adverse effect on migratory shorebirds and therefore would comply with EO 13186.

6.10 Executive Order 12898 (Environmental Justice)

Executive Order 12898 states that the federal government would review the effects of its proposed actions on low income communities. Federal agencies are “to the greatest extent practicable and permitted by law” identify and address “as appropriate, disproportionately high and adverse human health and environmental effects of its programs, policies and activities on minority populations and low-income populations in the United States."

Minority and Low Income Populations. In 2014, Carteret County was racially composed of 89.8% White, 6.3% Black, 4.0% Hispanic, 0.6% American Indian, 1.2% Asian, and 0.1% Native Hawaiian or Pacific Islander, and about 2.0% of the population identify with two or more races (US Census quickfacts 2014). Please note, the total racial percent of the population may be greater than 100% because Hispanic may be identified in more than one group.

Any individual with total income less than an amount deemed to be sufficient to purchase basic needs of food, shelter, clothing, and other essential goods and services is classified as poor. The amount of income necessary to purchase these basic needs is the poverty line or threshold and is set by the Office of Management and Budget (US Census 2014). The 2014 poverty line for an individual under 65 years of age was $12,316. The poverty line for a three-person family with one child and two adults was $19,055. For a family with two adults and three children, the poverty line was $28,252 (US Census quickfacts 2014).

Carteret County per capita income for 2013 was $27,496 and the median household income for 2013 was $46,534. In 2013, in North Carolina, the per capita income was $25,284 and the median household income was $46,334. In 2013 the poverty rate in Carteret County was around 14.4%, and for children ages 0-17 the poverty rate increased to 18.9%. In 2013 the poverty rate in North Carolina was 17.5% and for children ages 0 to 17 the poverty rate was 22.5% (US Census quickfacts 2014).

Figures 6-1 and 6-2, below show the minority/low-income populations and low-income communities in the project area which is taken from the 2010 US Census data.

The proposed action would impact the following areas: federal navigation channels in Morehead City Harbor, Brandt Island, Bogue Banks beaches, nearshore areas off Bogue and Shackleford Banks, and the ODMDS.

The USACE evaluated potential project impacts of the proposed long-term Harbor maintenance and found that the information shows that the proposed action would not cause disproportionately high and adverse impacts on minority populations or low-income populations. No impacts to either minority/low-income populations or low-income communities are anticipated as a result of the Proposed Action therefore the action would comply with EO 12898.

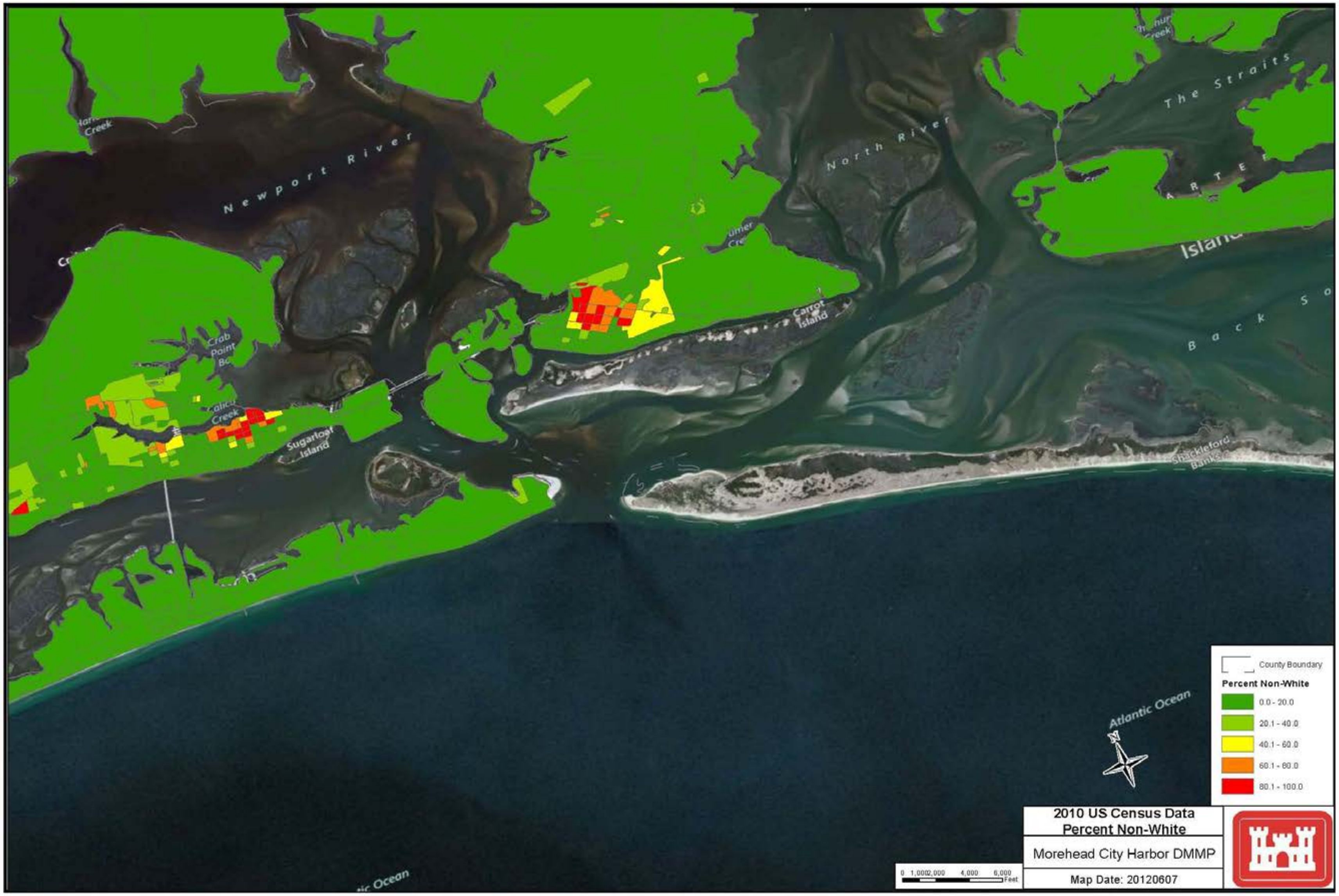


Figure 6-1. Minority Populations in the Project Area **(**US Census 2010)

Figure 6-2. Percent of Population Below Poverty Level (US Census 2010)

6.11 Executive Order 13045 (Protection of Children from Environmental Health and Safety Risks)

Executive Order 13045 states that the Federal government would review the effects of its proposed actions on children because they may suffer disproportionately from environmental health risks and safety risks. Federal agencies are to “identify and assess environmental health risks and safety risks that may disproportionately affect children;” and “ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.”

In Carteret County, persons under 18 years old make up about 19.2% of the population or about 12,762. Student enrollment for the 2010-2011 school year was about 8,550 in pre-kindergarten through 12th grade. There are eight elementary, four middle, and three high schools in Carteret County (US Census 2010).

In 2011, Carteret County managed 14 parks and 3 County school ball fields, ranging in size from 1 to 31 acres, located from Sea Level to Cedar Point, totaling approximately 200 acres (Carteret County Parks and Recreation Department 2011). Carteret General Hospital in Morehead City is the only hospital in Carteret County.

Figure 6-3, below shows the locations of parks, schools, and hospitals, within the project area where the majority of the construction would occur. These facilities are dispersed throughout the community and are not located disproportionately near the project area.

The work zone within the disposal area on the beaches of Bogue Banks will be fenced and the contractor will supervise all access to the construction site. Additionally, all work on these beaches will take place predominantly during the winter months of any year and the likelihood of children in the construction area is slight. No impacts to children are anticipated as a result of the proposed action.

Figure 6-3. Location of Hospital, Parks, and Schools in the Project Area.

6.12 North Carolina Coastal Zone Management Program

The proposed DMMP complies with the enforceable policies of North Carolina's approved coastal management program and will be conducted to the maximum extent practicable in a manner consistent with the program and any received authorizations. The paragraphs which follow support this determination.

Once the Final Environmental Impact Statement (FEIS) for the DMMP has been completed, the USACE will submit a separate consistency determination to the NC Division of Coastal Management in accordance with Section 307 (c) (l) of the Federal Coastal Zone Management Act of 1972, as amended.

The actions addressed in the DMMP will take place in the designated coastal zone of the State of North Carolina. Pursuant to the Federal Coastal Zone Management Act (CZMA) of 1972, as amended (P.L. 92-583), federal activities are required to be consistent to the maximum extent practicable with the federally approved coastal management program of the state in which their activities would be occurring.

Section 1102 (a) states that “clean, beach quality material from navigation channels within the active nearshore, beach, or inlet shoal systems must not be removed permanently from the active nearshore, beach or inlet shoal system unless no practicable alternative exists. Preferably, this dredged material will be disposed of on the ocean beach or shallow active nearshore area where environmentally acceptable and compatible with other uses of the beach.” When considering a project’s compliance with Section 1102, NCDCM has stated that the section should be read in concert with NCAC 7H.0208 (2)(G), which does provide some flexibility for publicly funded projects, allowing them to be considered by review agencies on a case by case basis with respect to dredged material disposal.

As outlined in the DMMP and its alternatives analysis, the majority of the clean, beach quality material (i.e., 90% or greater sand) removed from the Harbor will be placed on the Bogue Banks beaches, as well as the proposed nearshore placement areas.

The placement of dredged material on the ocean beach of Bogue Banks from Atlantic Beach to Pine Knoll Shores is consistent with the North Carolina Coastal Management Program. State concurrence with disposal of suitable maintenance dredged material (≥90% sand) from maintenance dredging of the Harbor navigation channels on Bogue Banks was obtained for the Section 933 in 2003.

The existing Western Nearshore Area off Bogue Banks was previously found to be consistent with the NC Coastal Management Program (NCCMP) in 1994 (CD94-29). Further study of the Nearshore Area, both by the USACE and other entities, solidifies the USACE’s belief that this disposal area is within the “active nearshore area” as outlined in section 1102(a). Specifically, recent analysis of the ebb-tide delta area of Beaufort Inlet indicates that material placed within the nearshore placement area appears to be diffusing and partially moving toward the northeast. This movement of material farther into the littoral complex is helping to reduce the deflation rate of the ebb-tide delta. Significantly, the USACE notes that there is no indication from the analysis of the available survey data that material is moving out of the nearshore area toward deeper water. The expansion of this nearshore area into shallower water closer to the shore should serve to hasten the movement of material into the center of the ebb-tide delta. Evidence suggests that material placed in the existing nearshore placement area appears to be moving toward the mouth of the inlet, and not moving into deeper water, and that littoral currents are operating on this material, and are moving this material farther into the shallow nearshore area. This data further reinforces the USACE position that the nearshore placement area is indeed within the shallow active nearshore area described in Section 1102.

In the past, when conditions were unsafe for navigation in the nearshore area, the dredging contractor had the option to take the dredged material to the ODMDS. Future contracts will include provisions to limit the amount of dredged material being disposed of in the ODMDS. The Wilmington District may allow dredge captains the discretion to place dredged material in the ODMDS when those captains believe that sea and weather conditions prohibit safe operation within the nearshore areas off Bogue and Shackleford Banks. Disposal of some beach quality material in the ODMDS when safety factors require has been the only circumstance where beach-quality material from the Harbor has been disposed of outside the active nearshore or beach system. While the USACE will continue to minimize disposal of material in the ODMDS as much as possible, the narrow dredging window (usually 90 days between January-March) often requires that dredge vessels work in adverse weather and seas and place some material in the ODMDS, in order to accomplish all dredging work within the short timeframes required.

Coarse-grained dredged material disposed of in the ODMDS is not necessarily being removed from the system permanently. This beach quality material is disposed of in a certain designated area within the ODMDS, so that it may be retrieved at a later date for beach placement. On three occasions, in 2004, 2007, and 2013, local governments removed approximately 1.2 million cubic yards of beach quality material from the ODMDS for use on the beaches of Bogue Banks. Additionally, both the USACE (in its Bogue Banks hurricane and storm damage reduction study and Carteret County (in its April 15, 2009 Request for Qualifications (RFQ) for a Master Beach Nourishment Plan) have identified the ODMDS as a primary source of borrow material for beach nourishment activities over the next thirty to fifty years. Specifically, Carteret County indicates that among potential borrow sites, “the ODMDS is preferable for many reasons.” In short, the DMMP does not propose to dispose of coarse-grained material in the ODMDS. As per the DMMP recommended plan, coarse-grained dredged material may only be placed in the ODMDS during adverse weather conditions in years 2 and/or 3 of the maintenance cycle when dredged material is to be placed in the nearshore areas. The USACE will continue to limit disposal of beach quality material in the ODMDS to that required for the safety of contractor vessels and crew. As such, the current and future use of the ODMDS is fully consistent with Section 1102.

6.12.1 Areas of Environmental Concern (AECs)

The proposed action would take place in areas designated under the NC Coastal Management Program as AECs (15A NCAC 7H .0100). Specifically, the activities will occur in three AECs, Estuarine Waters, Ocean Hazard, and Public Trust Area. The following determination has been made regarding the consistency of the proposed action with the State's management objective for the AECs that may be affected:

Estuarine Waters. Estuarine Waters are the state's oceans, sounds, tidal rivers and their tributaries, which stretch across coastal North Carolina and link to the other parts of the estuarine system: public trust areas, coastal wetlands and coastal shorelines. For regulatory purposes, the inland, or upstream, boundary of estuarine waters is the same line used to separate the jurisdictions of the Division of Marine Fisheries and the NC Wildlife Resources Commission. However, many of the fish and shellfish that spend part of their lives in estuaries move between the "official" estuarine and inland waters.

The proposed project would not adversely impact estuarine waters, since all dredging will take place within the existing Morehead City Inner Harbor channels and Brandt Island. On average, maintenance of these Inner Harbor channels take place every two years.

Ocean Hazard. The Ocean Hazard System is made up of oceanfront lands and the inlets that connect the ocean to the sounds. The beach disposal area of Bogue Banks is within the designated Ocean Hazard System. The Coastal Resources Commission has designated three-ocean hazard AECs.

1. The Ocean Erodible AEC covers North Carolina's beaches and any other oceanfront lands that are subject to long-term erosion and significant shoreline changes. The seaward boundary of this AEC is the mean low water line. The landward limit of the AEC is measured from the first line of stable natural vegetation and is determined by adding: a distance equal to 60 times the long-term, average annual erosion rate for that stretch of shoreline to the distance of erosion expected during a major storm. The width of the AEC varies from about 145 feet to more than 700 feet.

2. The High Hazard Flood AEC covers land subject to flooding, high waves and heavy water currents during a major storm. These are the lands identified as coastal flood with velocity hazard, or "V zones," on flood insurance rate maps prepared by the Federal Insurance Administration. "V zones" are determined by an engineering analysis of expected flood levels during a storm, expected wave and current patterns, and the existing topography of the land. The high hazard flood AEC often overlaps with the ocean erodible and inlet hazard AECs.

3. Unvegetated Beach Area AEC where no stable natural vegetation is present may be designated as an unvegetated beach area on either a permanent or temporary basis.

The proposed action would not adversely affect oceanfront lands and inlets on Bogue Banks. In fact, the disposal of beach quality sand from the maintenance dredging of Morehead City Harbor on the Bogue Banks beaches may reduce the erosion and storm damage potential.

Public Trust Areas. These areas include waters of the Atlantic Ocean and the lands there under from the mean high water mark to the 3-mile limit of state jurisdiction. The nearshore placement areas off Bogue and Shackleford Banks are located within these Public Trust Areas. The ODMDS is located past the 3-mile limit of State jurisdiction. Acceptable uses include those that are consistent with protection of the public rights for navigation and recreation, as well as conservation and management to safeguard and perpetuate the biological, economic, and aesthetic value of these areas. The activities that comprise the proposed action are not intended to adversely impact the public' rights for navigation and recreation, and are consistent with conservation of the biological, physical, and aesthetic values of public trust areas.

6.12.2 Other State Policies

The following state policies found in the NC Coastal Management Program document are also applicable to the proposed action in terms of beach disposal of sand.

Shoreline Erosion Response Policies. NC Administrative Code 7M - Section .0200 addresses beach restoration projects as feasible alternatives to the loss or massive relocation of oceanfront development when public beaches and public or private properties are threatened by erosion; when beach restoration, renourishment, or sand disposal projects are determined to be socially and economically feasible and cause no significant adverse environmental impacts; and the project is consistent with state policies for shoreline erosion response and state use standards for Ocean Hazard and Public Trust Areas AECs

Policies on Beneficial Use of Materials from the Excavation or Maintenance of Navigation Channels. NC Administrative Code 7M - Section .1101 states that it is the policy of the state that material resulting from the excavation or maintenance of navigation channels be used in a beneficial way wherever practicable. Policy statement .1102 (a) indicates that "clean, beach quality material dredged from navigation channels within the active nearshore, beach, or inlet shoal systems must not be removed permanently from the active nearshore, beach, or inlet shoal system unless no practicable alternative exists. Preferably, this dredged material will be disposed of on the ocean beach or shallow active nearshore area where environmentally acceptable and compatible with other uses of the beach."

6.12.3 Local land Use Plans

This proposed DMMP is also consistent with the policies addressed in the local Land Use Plans for Carteret County, as well as the Towns of Atlantic Beach and Pine Knoll Shores.

6.13 Coastal Barrier Resources Act (CBRA)

The proposed Morehead City Harbor DMMP is in compliance with CBRA. The Coastal Barrier Resources Act (CBRA) of 1982 (PL 97-348) and the Coastal Barrier Improvement Act of 1990 (PL 101-591) restrict federal expenditures in those areas comprising the Coastal Barrier Resources System (CBRS). Within the Morehead City Harbor project area, Fort Macon State Park Unit (NC- 04P) on Bogue Banks is within the Coastal Barrier Resource System and protected under the Coastal Barrier Improvement Act of 1990. However, the Fort Macon State Park Unit (NC-04P)is designated "P", which USFWS has defined as "otherwise protected area". Since the Fort Macon State Park Unit (NC-04P) is owned by the State of North Carolina this area would not need protection from future private development. Additionally, USFWS defines the "P" designation as an area that is not regulated by CBRA since it is State owned property and NPS managed property, respectively. The only restriction to Federal expenditures in these "P" designated areas is that federal flood insurance cannot be obtained.

6.14 Prime and Unique Agriculture Land

According to the Soil Survey of Carteret County, North Carolina, no prime or unique agriculture lands designated by the Natural Resource Conservation Service are found within the project area.

6.15 Environmental Commitments

1. If escarpments occur on the beach after disposal, the escarpment will be graded prior to the sea turtle nesting season during any given year in order to permit sea turtle nesting on the beach.

2. Should a hydraulic pipeline dredge be used offshore, the pipeline from the navigation channels to the disposal beach will be submerged until it reaches nearshore waters. The pipeline would be marked to let commercial and recreational boaters know of its presence along the bottom. Work barges and other appurtenances associated with a pipeline dredge operating in open water would be moored so as to minimize interference with boat traffic in the area.

3. Surveys of the project area for seabeach amaranth will be conducted prior to any disposal operation (construction) from 1 July to September 30 of any year.

4. Within Morehead City Harbor, some of the navigational channels are closed to shellfish harvesting. By Memorandum dated January 31, 2010, from the North Carolina Department of Environment and Natural Resources, Division of Environmental Health, Shellfish Sanitation and Recreational Water Quality Section (Appendix D), if maintenance material is excavated from these closed shellfishing areas between May 1 and October 31 and disposed of on Bogue Banks a swimming advisory will be posted and a press release made. The Wilmington District will notify the Shellfish Sanitation

and Recreational Water Quality Section prior to dredging from a closed shellfishing area with disposal on a recreational swimming area.

7 DMMP REVIEW PROCESS

7.1 Agency Technical Review (ATR)

The ATR of the Morehead City Harbor DMMP Alternative Formulation Briefing (AFB) report was completed by the Deep Draft Planning Center of Expertise (DDNPCX) in May 2010. The DDNPCX completed and certified the ATR for the Draft DMMP/EIS in November 2012. All ATR information is included in Appendix M.

7.2 Public Review of the Draft DMMP/EIS

7.2.1 Scoping

On November 26, 2007, a scoping letter for the proposed DMMP was sent to federal and state agencies, interest groups, and the public requesting identification of significant resources and issues of concern. In response to the scoping letter, the public and resource agencies expressed the following major concerns: fishery resources and habitats, rare butterfly habitat, short and long-term impacts of the proposed activity, endangered/threatened species, cultural resources, sediment contamination, and other natural resources. A copy of the scoping letters and all comments are provided in Appendix D, Public and Agency Correspondence. All concerns from the scoping letters and meetings were considered in the development of the recommended plan.

On March 4, 2009, a public meeting was held to brief attendees on the Morehead City Harbor DMMP project and process, to solicit comments and input and to invite attendees to participate on the Project Delivery Team (PDT). Attendees included representatives from state and federal resource agencies, interest groups, and stakeholders. All concerns identified in response to the scoping letter and at the public meeting were considered in the development of the Draft DMMP. Several attendees of the public meeting expressed an interest in participating on the PDT and have actively participated in the development of the DMMP. The full list of participants is included in Section 13 (Project Delivery Team).

A Notice of Intent (NOI) to prepare a Draft Environmental Impact Statement (DEIS) was published in the Federal Register on March 27, 2009 and a copy of the NOI is also found in Appendix D.

In addition to the public meeting held in 2009 and involvement by various resource agencies and stakeholders throughout the planning process, USACE has also coordinated extensively with the National Park Service regarding potential DMMP measures that may impact Cape Lookout National Seashore. By letter dated February

15, 2011, USACE formally named the NPS as a cooperating agency on the DMMP (Appendix D).

By letter dated June 27, 2011, USACE initiated consultation with thirteen federally recognized tribes identified as possibly having an interest in the project area. Only one tribe, the United Keetoowah Band of Cherokee Indians of Oklahoma (UKBCIO) responded. By letter dated July 15, 2011 the UKBCIO stated they had no objections to the DMMP, but would like to be contacted should any remains, artifacts or other items be inadvertently discovered (Appendix D).

7.2.2 Coordination of this Document

In October 2013, the Draft DMMP and EIS was provided to a standard list of federal, state, and local agencies; elected officials; environmental groups; and known interested individuals for a 45-day review and comment period (see list below in Section 7.4.3). The comments received and responses to comments are included in Appendices D and L, respectively. All input received has been considered in the preparation of this Final DMMP and EIS.

7.2.3 Recipients of this Document

Representatives
Honorable Richard Burr
HonorableThom Tillis
Honorable Walter B. Jones, Jr.
NC Representative Pat McElraft

Federal Agencies
Beaufort Marine Fisheries Center, National Marine Fisheries Service
Center of Disease Control
Commander, Fifth Coast Guard District
Director, Office of Environmental Compliance, Department of Energy
Director, Office of Environmental Policy & Compliance, DOI
Environmental Conservation Office, Department of Commerce, NOAA
Executive Director, Advisory Council on Historic Preservation
Federal Highway Administration
Forest Service, USDA
HUD, Atlanta Regional Office
Office of the Solicitor, Energy and Resources, U.S. Department of the Interior
Raleigh Field Office, U.S. Fish and Wildlife Service
Regional Director, National Park Service
Seymour Johnson AFB
Superintendent, Cape Lookout National Seashore
U.S. Environmental Protection Agency, Office of Federal Activities
U.S. Environmental Protection Agency, Region IV

State Agencies
CAMA Officer, Town of Atlantic Beach
CAMA Officer, Town of Pine Knoll Shores
North Carolina State Clearinghouse
North Carolina Division of Coastal Management

Local Government
Carteret County Board of Commissioners
Carteret County Register of Deeds
Carteret County Building Inspections, Larry Smith
Mayor, Town of Atlantic Beach
Mayor, Town of Pine Knoll Shores
Mayor, Town of Indian Beach
Town Manager, Atlantic Beach
Town Manager, Pine Knoll Shores
Town Manager, Indian Beach

Independent Groups and Individuals
Conservation Council of North Carolina
Cape Fear Group Sierra Club
Defenders of Wildlife
Dr. Vince Bellis
Dr. Robert Dolan, University of Virginia, Charlottesville
Dr. Bill Cleary, University of North Carolina at Wilmington.
Dr. Martin Posey, University of North Carolina at Wilmington
Dr. Orrin Pilkey, Duke University
Mr. Ray P. Brandi, Cape Fear Community College
National Parks and Conservation Association
National Audubon Society, Southeastern Regional Office
North Carolina Wildlife Commission
National Wildlife Federation
North Carolina Environmental Defense Fund
North Carolina Coastal Federation
North Carolina Fisheries Association
National Wildlife Refuge Association
Wilderness Society
Sierra Club Legal Defense Fund

Newspapers
Carteret County News-Times

Libraries
N.C. Collection, Wilson Library, UNC-Chapel Hill
N.C. Dept. of Environment, Health, and Natural Resources Library
Randall Library, UNC-Wilmington
State Library of North Carolina
Joyner Library, East Carolina University

8 DMMP APPROVAL AND IMPLEMENTATION

8.1 DMMP Approval

Comments received during public review of the Final DMMP/EIS will be considered and, if appropriate, a Record of Decision will be signed, thus completing the NEPA process. The Final DMMP/EIS may be approved by the USACE South Atlantic Division (SAD) Commander.

8.2 DMMP Implementation

Implementation of the DMMP will begin during the first dredging cycle following approval by SAD. It should be noted that maintenance of the Morehead City Harbor is currently based on a 3-year cycle, very similar to the base plan in the DMMP. Therefore, once the DMMP is approved, implementation will begin in a logical sequence and may not necessarily begin with the first year of the DMMP 3-year cycle. As an example, if dredged material is disposed of on the beaches just prior to DMMP approval then implementation will begin with year 2 of the base plan when the beach quality dredged material is to be placed in the nearshore placement areas. The DMMP will be periodically reviewed and updated as appropriate.

9 CONCLUSION

Pursuant to 33 C.F.R. § 335.7, federal standard means the dredged material disposal alternative or alternatives identified by USACE which represent the least costly alternatives consistent with sound engineering practices and meeting the environmental standards established by the 404(b)(1) evaluation process (Appendix H) or ocean dumping criteria. The DMMP recommended plan provides the least cost, engineeringly sound, environmentally acceptable alternatives for disposal of maintenance dredged material from Morehead City Harbor for at least the next 20 years and therefore meets the federal standard.

It is the policy of USACE that all dredged material management studies include an assessment of potential beneficial uses for environmental purposes including fish and wildlife habitat creation, ecosystem restoration and enhancement and/or hurricane and storm damage reduction. This DMMP attempts to maximize beneficial uses of dredged material within the requirements of the federal standard. Coarse-grained material would be placed of on the beaches of Fort Macon State Park and Atlantic Beach, or in the nearshore placement areas to replenish the deflated ebb tide delta. Stakeholders strongly support placement of coarse-grained material on the adjacent beaches. The beaches that would receive material from the Morehead City Harbor navigation project are public beaches that provide several access points for the general public.

Additionally, the proposed plan is fully consistent with the State's Coastal Management Program, which states that clean, beach quality material from navigation channels within the active nearshore, beach, or inlet shoal systems must not be removed permanently from the active nearshore, beach or inlet shoal system unless no practicable alternative exists (15A NCAC 07M.1102 (Section 1102) (a)). Analysis of past dredging operations between years 1995 and 2006 indicates that approximately 43 percent of coarse-grained material destined for the Nearshore West was diverted to the ODMDS due to weather restrictions. In the future every reasonable effort will be made to reduce the amount of coarse-grained material being disposed of in the ODMDS.

Fine-grained material for which no cost effective beneficial use has yet been identified would be disposed of in either Brandt Island or in the ODMDS. Implementation of the proposed base plan would result in approximately 79% of the dredged material from the Morehead City Harbor project being beneficially used. The PDT seriously considered beneficial uses applied at other locations and the alternatives considered for this DMMP are a result of extensive coordination between the PDT, resource agencies and stakeholders.

The proposed Morehead City Harbor DMMP is not expected to result in any significant adverse environmental effects. Significant resources (including terrestrial and marine biota, cultural resources, threatened and endangered species, air and water quality, socio-economics, aesthetics, and recreation) will not be adversely impacted by implementation of the proposed DMMP. Localized, short-term, and reversible adverse impacts to intertidal macrofauna (beach infauna) may occur. However, beach disposal areas on Bogue Banks would recover quickly since only beach compatible sand (≥90% sand) would be disposed of on these beaches. No long-term adverse impacts to intertidal macrofauna (beach infauna) or any other significant resources are anticipated.

The three year dredging cycle proposed for the DMMP assumes that funding will be available to dredge and monitor as planned, appropriate dredge equipment will be available, and that unexpected shoaling would not occur. The three year rotational cycle is the base plan, but must remain flexible and adjustable to meet the navigation needs of the Morehead City Harbor Navigation project, therefore, from time to time, the cycle may be adjusted, resulting in fewer dredging events and dredged material quantities that differ from those described in this DMMP. Nothing in this document should be read to suggest that material will be dredged for the purpose of disposal on the beaches or in the nearshore, or for any purpose other than addressing navigation priorities.

10 NON-FEDERAL PARTNER

The State of North Carolina has statutory authority under the federal Water Resources Development Acts of 1986 & 1992 (Public Laws 99-662 and 102-580, respectively) to make binding commitments to carry out the non-federal responsibilities related to USACE projects, including making cash contributions to projects. Cost sharing is being done in accordance with the current Project Cost share Agreement (PCA), dated 15 September 1993. Specifically, the non-federal partner obligations for the Morehead City Harbor, NC navigation project are to provide all lands, easements, and rights-of-way, including suitable borrow and excavated or dredged material disposal areas, and perform, or assure performance of, all alterations or relocations of facilities and utilities (except alterations or relocations of highway bridges and railroad bridges and approaches thereto), determined by the Government to be necessary for construction, operation, maintenance, repair, replacement, and rehabilitation of the Project. The only costs incurred by the non-federal partner are approximately $50,000 annually for maintenance of the spillway boxes at Brandt Island. The general navigation features (maintenance dredging) of the Project are 100% federally funded.

11 PROJECT DELIVERY TEAM (PDT)

U. S. Army Corps of Engineers

Name	Role	Office Symbol
Bob Keistler	Project Manager	CESAW-PM-PM
Jenny Owens	Plan Formulator	CESAW-TS-PE
Frank Reynolds*	Economist	CESAW-TS-PS
Chris Graham	Economist	CESAW-TS-PS
John Mayer**	Archaeologist	CESAW-TS-PE
Kevin Conner	Coastal Engineer	CESAW-TS-EC
Hugh Heine*/Jeff Richter	Biologist	CESAW-TS-PE
Jimmy Hargrove	Civil Engineer	CESAW-TS-ED
Ben Lackey	Geotechnical Engineer	CESAW-TS-EG
John Caldwell	Cost Engineer	CESAW-TS-EE
Justin McCorcle	Legal	CESAW-OC
Elaine Hayes*	Navigation	CESAW-OP-N
Donnie Potter	Navigation	CESAW-OP-V
Belinda Estabrook	Real Estate	CESAS-RE-RP

Resource Agencies and Stakeholders

Name	Agency
Dave Allen	NC Wildlife Resources Commission
Sara Schweitzer	NC Wildlife Resources Commission
Maria Dunn	NC Wildlife Resources Commission
Buck Fugate	Carteret County, NC
Michael Rikard*	National Park Service (CALO)
Jodi Eshleman***	National Park Service
Mark Kinzer	National Park Service
Rebecca Beavers	National Park Service
Julia Brunner	National Park Service
Rudi Rudolph	Carteret County, NC
Ron Sechler*	National Marine Fisheries Service
Todd Walton	NC State Ports
Chris Southerly	NC Office of State Archaeology

* Retired ** No longer with USACE ***No longer with the NPS

12 POINT OF CONTACT

Written comments regarding this Final DMMP and Environmental Impact Statement (DMMP/EIS) should be sent to Mr. Eric Gasch, CESAW-ECP-PE, U.S. Army Engineer District, 69 Darlington Avenue, Wilmington, North Carolina 28403. Questions may be directed to Mr. Gasch by telephone (910) 251-4553 or by e-mail at Eric.K.Gasch@usace.army.mil.

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